Escola Politècnica Superior
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UNIVERSITAT POLITÈCNICA DE CATALUNYA

FINAL PROJECT

TITLE: **APPLICATION OF LEAN MANAGEMENT TO THE TOURISM, HOTEL AND/OR RESTAURANT SECTOR.**

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This project includes lifecycle environmental considerations : Sí No

RESUMEN

En este trabajo se refleja como la metodología de la Gestión Lean puede ser aplicada y favorecedora para las empresas dedicadas al sector de la restauración. Se exponen las dificultades organizativas y de gestión de este tipo de negocios, se identifican los problemas actuales y se aportan soluciones de mejora a partir de la implementación de diferentes herramientas Lean. Se pretende acercar este modelo de gestión nacido en las industrias a empresas más pequeñas como es la de restauración.

En la primera parte del trabajo se explica la estructura que se va a seguir y la motivación que ha llevado a realizar-lo. Seguidamente se hace una pequeña introducción al mundo de la restauración para saber cómo funcionan estos negocios y su evolución. También se presenta el modelo de Gestión Lean y las herramientas y conceptos que se aplicaran en el resto del trabajo.

En la segunda y tercera parte del trabajo se hace una descripción del entorno, el estado del sector y del restaurante de estudio. A partir de la aplicación de herramientas Lean se identifican ineficiencias en el servicio y se proponen soluciones para mejorar.

Además, se ha hecho un estudio de los datos reales recopilados durante el proyecto y se han propuesto mejoras tanto en la metodología como en la organización del trabajo y de los trabajadores.

Finalmente, se han extraído algunas conclusiones que intentan aportar valor y demostrar la viabilidad de las propuestas aplicadas a nuestro negocio y a empresas de características similares.

Palabras clave (máximo 10):

Restaurante	Procesos	Makigami	Supermercado
Cocina	Lean	Spaghetti chart	Cycle Time
Organización	5s		

ABSTRACT

In this work it is reflected how the Lean Management methodology can be applied and favoured for companies dedicated to the restaurant sector. The organizational and management difficulties of this type of business are explained, current problems are identified and improvement solutions are provided through the implementation of different Lean tools. The aim is to bring this management model born in the industries closer to smaller companies such as the catering industry.

The first part of the work explains the structure to be followed and the motivation that led to it. The following is a brief introduction to the world of catering to find out how these businesses work and how they evolve. It also presents the Lean Management model and the tools and concepts that will be applied in the rest of the work.

In the second and third part of the work there is a description of the environment, the state of the sector and the restaurant is made as a practical case study. From the application of Lean tools, inefficiencies in the service are identified and solutions for improvement are proposed.

In addition, a study has been made of the actual data collected during the project and improvements have been proposed in both the methodology and the organisation of work and workers.

Finally, some conclusions have been drawn that attempted to provide value and demonstrate the viability of the proposals applied to our business and to businesses with similar characteristics.

Keywords (10 maximum):

Restaurant	Processes	Makigami	Supermarket
Kitchen	Lean	Spaghetti Chart	Cycle Time
Organization	5s		

SUMARI

1. INTRODUCTION

1.1 PROJECT ORIGINS AND MOTIVATION

Nowadays there are many services offered to us, whether they are medical services because we have become ill on time or more basic and daily services such as catering or transport services or hotel services when we travel. These are some of the most common examples that we find daily in our routine, which do not always work in the most efficient way and we all quickly see what we don't like about them or what we would change to improve our time spent in those services.

After observing the changes and improvements obtained in some of the services mentioned above, I wanted to focus on a service that most of us use every day, the Restoration. We always find that in many cases it is not efficient and could be done better, reducing waiting times and making the customer happy to return.

Thanks to the knowledge acquired during all these years of university I have been able to assess and look for solutions to any problem that arose and in this way I have been able to carry out this project. It has been carried out under a basic perspective in terms of technology and more emphasis has been placed on organisational and management concepts.

1.2 PROJECT OBJECTIVES

The main objectives of this project are the application of Lean Management in the restoration sector to achieve greater efficiency, optimization of time and provide solutions to current problems encountered and improve the competitiveness and profitability of the company.

1.3 METHODOLOGY

During this project we study how Lean Management applied correctly to the restoration sector has a positive effect. To begin with, the evolution of the restoration sector in history has been studied, so that we can position ourselves correctly and define our starting point.

Once our starting point had been defined, the current situation on which we are going to focus was described in order to see the magnitude and impact of the study that it could have. A restaurant located in Andorra has been chosen to provide a real and scalable example that will help to give a more tangible idea of the studio. The fact of choosing Andorra is due to its tourist character, the number of different restaurants that are offered on the same street and the volume of people who pass through the restaurants in high season.

The concept of Lean Management is introduced and the characteristics of this business model that began in the automotive industry in the 20th century are explained.
The basis of the project is the application of different Lean tools to observe, describe and analyse a real situation.

Finally, some improvements are proposed to improve the restaurant's service (in some of them Lean IT could be applied). The conclusions obtained during the whole project will be extrapolated to other case studies similar to ours.

1.4 BACKGROUND

From 1700 B.C. onwards, the first taverns were known to exist where people would relax, gather and disconnect. Initially, the taverns only offered drinks, more specifically wine, to their customers and were regulated by an association or guild that allowed them to self-regulate their functions, thus avoiding any unfair competition.

The Romans were the ones who most promoted the subject of eating out, making food buffets where they spent hours eating and talking.

The first restaurants appeared in the 13th century. From that moment on, a distinction is made between restaurants and bars focused on food and drinks.

From 1765 onwards, the first restaurant itself appeared in Paris. In the years that followed, a number of establishments were opened in Paris that served on the table, in individual portions. But it will be the Revolution that will make them succeed. They began to export out of France, all over the world and the demand for men to work in these culinary tasks grew.

In 1879 the first cash register appeared. This was a big breakthrough, the commands to charge customers went from being handwritten to being printed. The next step was the appearance of the computers and cash terminals (dataphone) and with it they were able to carry out a global control of the business apart from having all the commands registered and the convenience and facility of the client to be able to pay the bill with a credit card.

Despite all the technological advances and process management, we find ourselves with many owners who keep doing things as they always have done. This fact limits the expansion or adaptation of the locals to the current reality.

Customers are looking for cozy places with good service, personalized attention and quality food and drink at a reasonable and affordable price. The fact that in many locals they have not adapted to the change and the new processes means that these conditions are not met and that they do not offer a good service and in the end they end up losing customers, which means a loss of money and finally the closure of the local.

We will be able to see that from the application of Lean Management in these locals we

will be able to keep them open offering the best service.

1.5 LEAN CONCEPT

Lean Management is an approach to managing the performance of an organization or a business that is based on the concept of continuous improvement, a long-term approach to working from small, incremental changes in processes to improve efficiency and quality.

The Lean Manufacturing System has its origin in the production system developed by the Japanese car manufacturer Toyota Taiichi Ohno in the 1950s. It is now known as the Toyota Production System (TPS).

The main objective of TPS is to reduce cost and improve productivity by eliminating activities that do not add value to the product or the customer. Due to the Second World War and subsequent economic pressures, Japan suffered from a lack of resources in the 1950s which led to the accumulation of inventories and the non-sale of expected units and led to major financial problems for Toyota. Looking for a solution to their problems, they looked to Ford's mass production, but Taiichi Ohno realized that this production system operated with a lot of MUDA (waste) in all areas, from personnel, space and time spent, raw materials or excess processing and inventories.

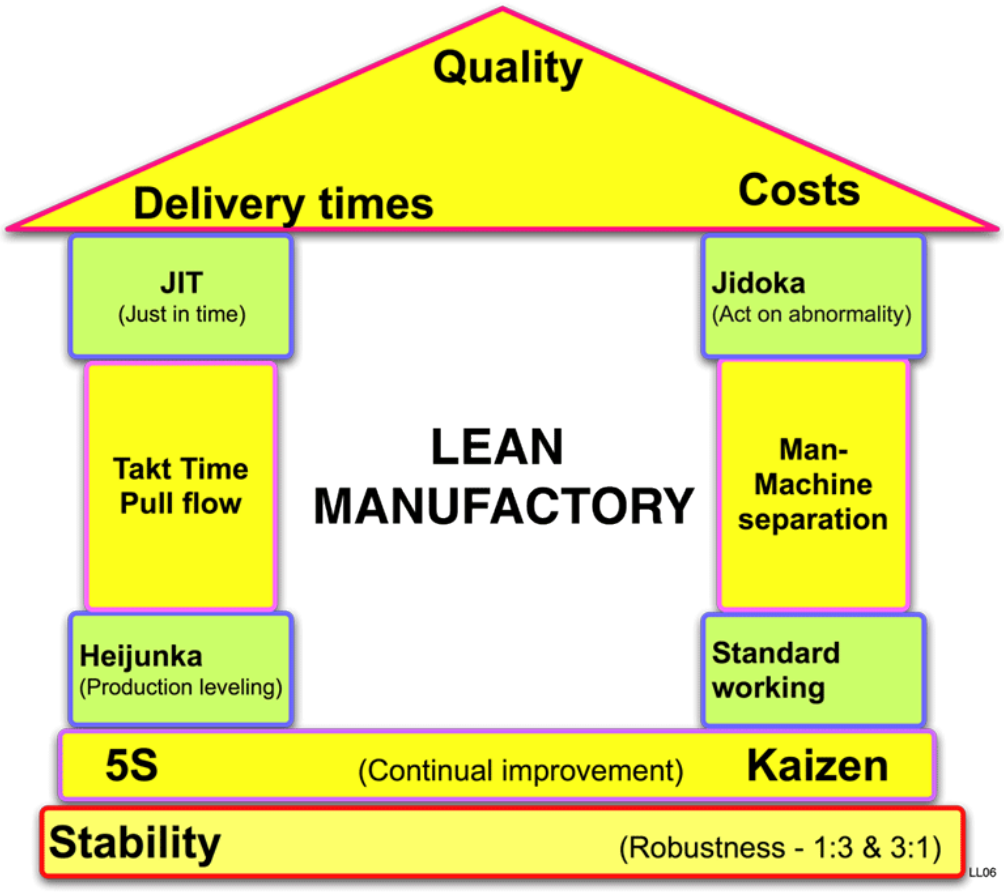


Figure. 1 Lean production system (wikipedia)

The Lean method is based on continuous improvement focused on five principles:

- Identification of the Added Value and Non-Added Value.
- Value stream identification.
- Work in flow eliminating waste (“Just in Time").
- Working on the "Pull Flow" throughout the process.
- Pursuing perfection (0 quality defects).

The following explains the seven wastes that have been defined with this system, which are harmful to a company:

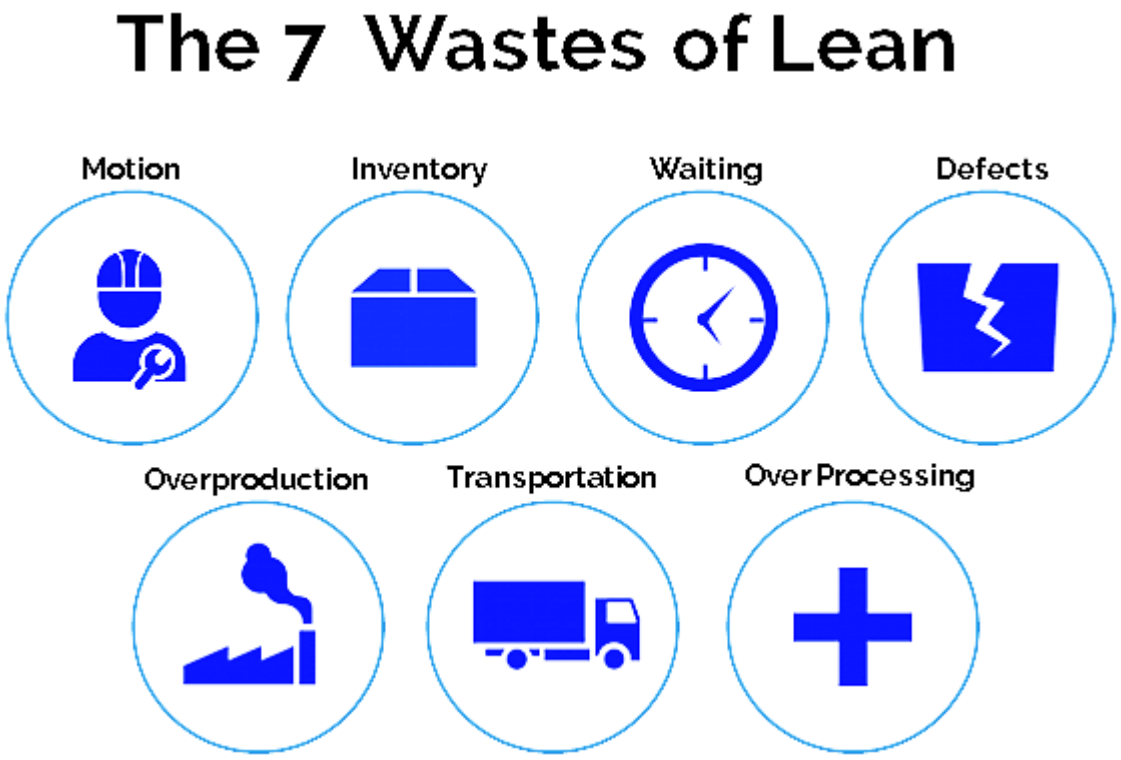


Figure. 2 The 7 wastes of lean (leanmanufacturingsecrets.com)

- **Overproduction:** Basically it consists of producing more than is needed at the moment. The Lean principle is to use a "pull" system or to produce on demand.
- **Inventory**: Extra Storage of material in case it is needed to satisfy customer or product demand. It has a negative influence on the process and space flow.
- **Movement**: The Unnecessary movements that are executed to perform an activity for the product or service.
- **Defects:** Service or product that does not meet the expectations required to meet minimum standards satisfactory. Consumption of materials, manpower to reprocess, reworks and to attend to customer complaints.
- **Waiting:** Time that during the process does not add value to the product. It includes downtime waiting for a material, an inspection, breakdowns, etc. It sometimes influences the overproduction.
- **Over-processing:** Performing unnecessary processes to process items, use inappropriate tools or equipment or add higher quality levels to customer requirements.

- **Transport:** Displacement or movement of material or people who do not add value to the product or service.

If we look at the overall picture of a restaurant, we can identify some of the waste defined above, for example:

We would speak of overproduction to the early preparation of many dishes and in large quantities of specific dishes for example from a menu of the day because it is supposed to be the most consumed.

If the cook uses a small pot and pan instead of a large one to make 40 portions of macaroni, we would be talking about over-processing.

A defect would be the preparation of a dish with an ingredient that the customer has not ordered or vice versa, without an ingredient that has been ordered and not added.

The movement of dismantling and setting up a dining table wastes time, movement and transportation, as does walking around the tables to check how they are going and not carrying or removing any dishes.

All products that are purchased "just in case" could be ordered by a customer and all those that are not purchased on demand would be a waste of Inventory.

On the other hand, we also have to comment on the concepts of "Just in Time" and the queuing theory.

The "Just in Time" methodology is based on manufacturing products that are strictly necessary, at the right time and in the right quantities: you have to buy or produce only what you need and when you need it. Reducing stocks while strictly maintaining the necessary ones is one of its main objectives. It is an industrial philosophy of eliminating everything that involves waste or squandering in the production process from purchasing to distribution.

The JIT is linked to the 5s methodology, continuous improvement and waste. The 5S method is a Japanese management technique based on five simple principles, which are used for the best use of the workplace:

Figure. 3 5S diagram (clientsfirst-tx.com)

Seiri (Sort): Eliminate all unnecessary and expendable elements to perform our action in our workspace.

Seiton (Set in Order): Organize items classified as necessary so that they can be found easily.

Seiso (Shine): Identify and remove dirt and perform maintenance actions to keep the workspace clean.

Seiketsu (Standardize): To normalize the workplace so that irregular or abnormal situations can be detected, using simple rules that are visible to everyone.

Shitsuke (Sustain): Make it a habit to use established and standardized methods for cleaning in the workplace. It is a channel between 5S and continuous improvement.

Based on these methodologies, waste can be identified and continuous, effective and uniform improvement can be achieved.

1.6 THEORY OF CONSTRAINTS

The Theory of Constraints (TOC) is a methodology for identifying the most important limiting factor (i.e. constraint) that stands in the way of achieving a goal and then systematically improving that constraint until it is no longer the limiting factor. In manufacturing, the constraint is often referred to as a bottleneck.

Dr. Eliyahu Goldratt conceived the Theory of Constraints, and introduced it through his novel, “The Goal”. Since then, TOC has continued to evolve and develop, and today it is a significant factor within the world of management best practices.

One of the appealing characteristics of the Theory of Constraints is that it inherently prioritizes improvement activities. In environments where there is an urgent need to improve like in a Restaurant, TOC offers a highly focused methodology for creating rapid improvement.

The Theory of Constraints provides a specific methodology for identifying and eliminating constraints, referred to as the Five Focusing Steps, it is a cyclical process.

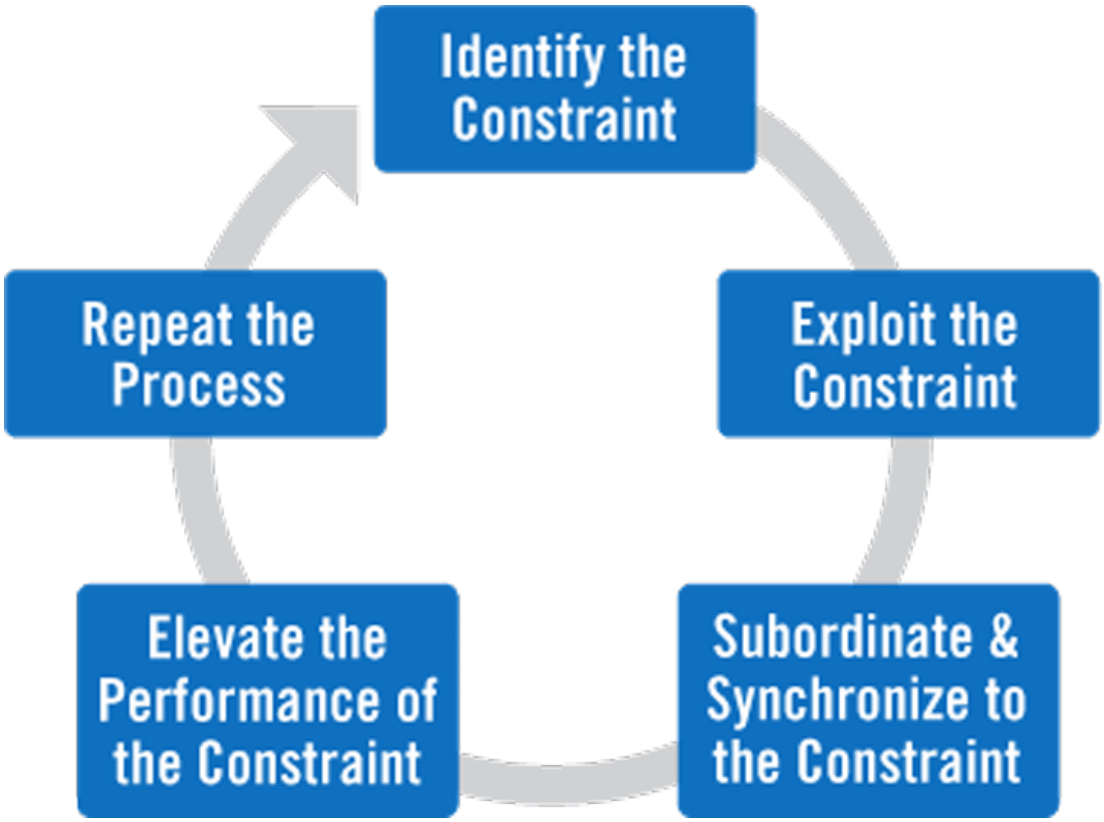


Figure. 4 Theory of constraints flow (leanproduction.com)

1.7 QUEUEING THEORY

Queueing theory is the mathematical study of waiting lines of inside a system. A queueing model is constructed so that queue lengths and waiting time can be predicted. The results are often used when making business decisions about the resources needed to provide a service.

The ideas have since seen applications including telecommunication, transport, and, particularly in industrial engineering, in the design of factories, shops, offices, hospitals and restaurants, as well as in project management.

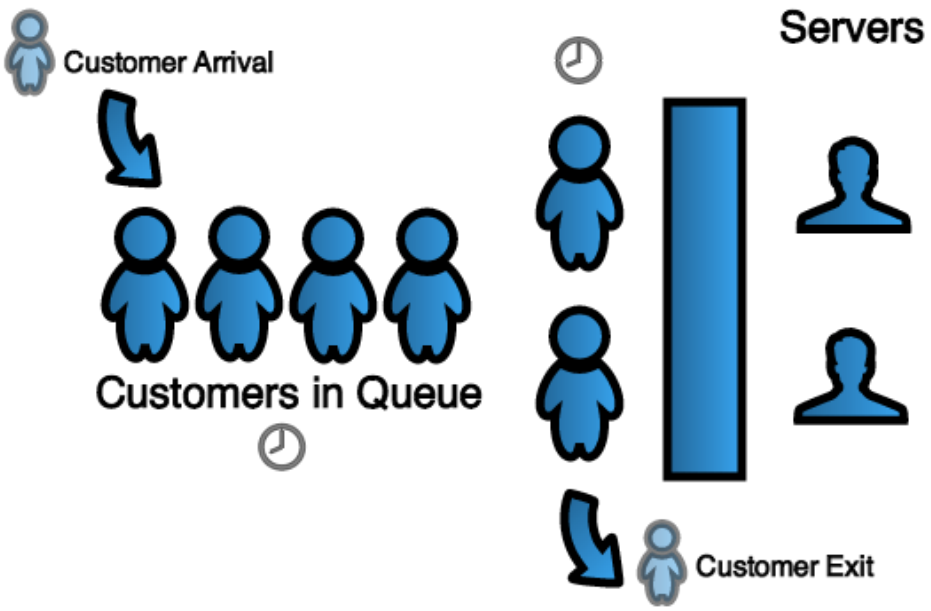


Figure. 5 Queueing theory flow (feasible-cloud-computing-architecture)

2. DESCRIPTION OF THE ENVIRONMENT

2.1 ACTUAL STATE OF THE RESTAURANT SECTOR IN ANDORRA

In recent years the world has evolved technologically, making life and services easier for people. The appearance of new technological objects such as smartphones that seemed impossible to imagine years ago are now part of our daily life and have become a necessity just like the Internet.

Little by little these new technologies have been introduced in our lives to facilitate, speed up and optimize our daily work. The same thing has happened in the catering sector, although in a smaller way compared to other sectors dedicated to the service. The cash register or small handheld computers for writing down orders and receiving them in the kitchen are some examples of the technological advances in the catering sector.

In this case we have focused on Andorra, a small country located in the Pyrenees between Spain and France. Characterized by its tourism all year round but especially in the winter season as it has large ski slopes facilities. Andorra mainly lives from tourism and as a result offers many services focused on them as well as a wide variety of restaurants throughout its domain. Not only does tourism frequent these restaurants, but the locals themselves also like to go out for lunch or dinner out of the house, either out of necessity or for leisure.

Figure. 6 Andorra map

It is clear that we live in a society that allocates a large part of its money to these premises and that catering is a sector in which a lot of money moves. The need to have to eat out every day due to working hours makes catering entrepreneurs try to spend more time on improvements and upgrades in their premises adapting to the needs of the user.

Despite being aware of all this, many entrepreneurs do not apply it in their businesses, do not even know Lean Management and base the operation of their business on a constant improvisation of what they think is best.

On the other hand, we are in a sector which is aware of the basic principles of Lean

Management and which systematically controls your company and applies standardized processes in its daily work.

2.2 FIGURES

Andorra is a country whose main source of income, as we have already said, is tourism. According to surveys conducted by the Andorran statistics service and the latest version of the book "Andorra in Figures" of 2016, we know that, despite the crisis that is gradually improving, the number of visitors to the country in 2017 was 8,152,148. The annual average is between 8 and 10 million people and the number of establishments (hotels and restaurants) as of December 2016 was 1,029.

The national consumption by groups (2012) in hotels, cafés and restaurants is approximately 122 million euros. According to the GVA by sector, in 2014, 175.9 million euros were spent in the hotel and catering sector, which corresponds to 7.0% of the GDP.

These figures give us an idea of the number of people who eat and dine away from home and therefore the volume of the catering sector and it's potential.

Figure. 7 Andorra Centre (mountainhosteltarter.com)

2.3 EXAMPLES OF LEAN APPLICATIONS

2.3.1 365 Café

The company "365" has been applying Lean tools and processes that have allowed to improve the final customer experience. With a good definition and distribution of tasks in the store, they have managed to reduce the waiting time of customers and has increased the freshness of their products, reducing staff costs, applying standards adapted to each point of sale.

The biggest change they brought in after lean came into the picture was a clear division of tasks and competences within our shops, as per the image be.

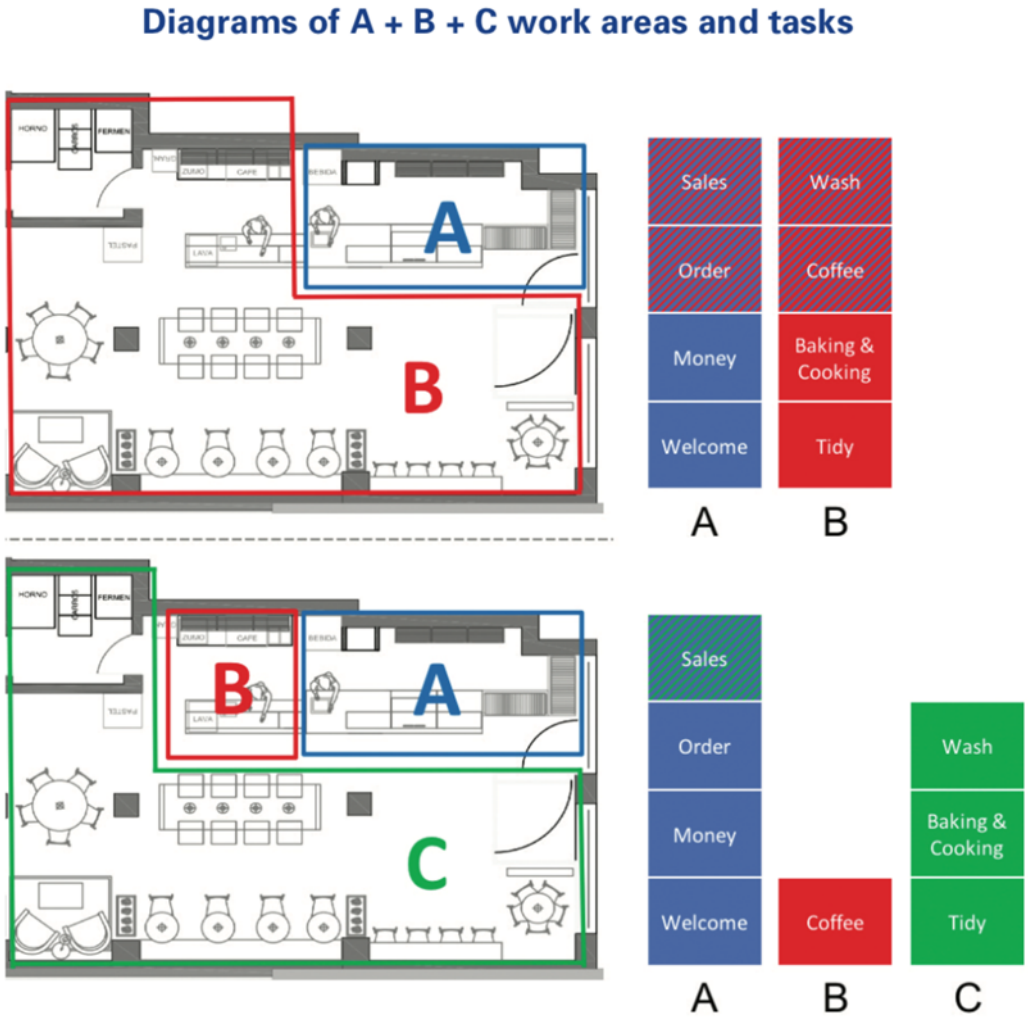


Figure. 8 365 cafe distribution

Lean was introduced in the shops in 2011, when they saw that the factory was working well. The separation of tasks (person A works at the till, while person B makes the coffee) leaves no room for confusion, while a very effective kanban system at the back

sends input to the factory to ensure replenishment takes place.

The improvements in the shops were tangible early on: employees kept the shops tidier, there was no overlapping of roles among staff members, and of course the customer's experience improved.
All the yelling, all the waiting, all the 'where's my coffee?' that they had before... it all disappeared. Today clients are being served more quickly, and everything is under control, which makes for a nicer experience for everybody.

2.3.2 Jaguar – Land Rover Example.

At the Jaguar car production plant in Castle Bromwich (Birmingham) the production line has been designed using the principles of lean production.

In the ‘old days’ Jaguar production took up much more Factory space because a lot of stocks and supplies were kept on the Factory floor. Nowadays all stocks are kept in a separate storage area where they are delivered just-in-time to feed the production process.

On the production line operative’s work with the minimum required quantity of stocks. When more are needed, production line workers use a ‘Kanban’ signalling system to inform the stores that they need more suppliers.

2.3.3 Nike

The company of Oregon worked with NGOs and fellow manufacturers on sustainability projects. They worked with the Fair Labor Association to create performance indicators and sustainable sourcing and launched the Sustainable Apparel Coalition with the US Environmental Protection Agency and other manufacturers, and in the process saved money on energy and waste materials.

2.3.4 Kleenex

Kleenex recently outsourced logistics at its Barton Mill UK plant to leading Lean thinkers, Unipart. Before this, staff at the plant resented the long shifts and overtime and absenteeism was at 10 percent. Unipart got Kimberley-Clark to spend on enhanced staff engagement and development, meaning they saved on staff absenteeism and through an improvement in efficiency brought about by better staff morale

2.3.5 Intel

Intel is the world’s largest computer chip maker. Joe Foley, factory manager at Intel Fab Operations in Leixlip, Ireland, said: “Five years ago, it took us 14 weeks to introduce a new chip to our factory; now it takes 10 days. We were the first Intel factory to achieve these times using Lean principles.”

2.3.6 Toyota

The Toyota philosophy – and it truly is a philosophy – has helped make Toyota the world top three car company it is today, and has resulted in the 'Lean' concept, replicated worldwide.
Lean manufacturing is a management philosophy derived mostly from the Toyota Production System (TPS), an integrated socio-technical system which comprises its management philosophy and practices.
A socio-technical system is an approach to complex organisational design that recognises the interaction between people and technology in workplaces.
Sometimes referred to as the Toyota Way, the TPS' main objectives are to design out overburden and inconsistency and to eliminate waste. Waste not only refers to materials, but time, such as consumer time waiting for product or assistance and even waste of movement. The philosophy also relies on the process being as flexible as possible to reduce stress, which counts as overburden and generates waste.

2.3.7 Taco bell

One of the first companies on record to apply lean service and solve its "tradeoffs" between efficiency with low cost operations and flexibility.
https://medium.com/@timfrietas/lessons-in-product-management-from-taco-bell-part-1-3ae53e8313f8

2.3.8 Red Bull Racing - Formula One Pit Stop

The Red Bull Racing (Winners a award for beging the best pit crew in 2017) demonstrates Lean concepts perfectly in their pit stops. Many of the principles of Lean Thinking have been applied here, not just quick changeover.

1. Internal tasks have been transferred into external tasks at every opportunity to reduce downtime / changeover time.
2. 5S is applied in that the entire pit stop area and garage is laid out for maximum flow and minimum effort in completing the tasks of getting the F1 race car on the track, refuelling it and fitting new tyres during the race.
3. Minimum movement is exhibited by the team during the pit stop process.
4. The process is balanced perfectly so that the cycle time for completing every task matches the duration of all of the others.

3. REAL CASE STUDY

Having studied and analysed the whole concept Lean Manufacturing is time to apply everything in a particular case. In our case we have chosen a restaurant in the capital of the Principality of Andorra. We have chosen this place for its disposal as it is in the busiest city center and surrounded by different restaurants that have similar characteristics and comparisons are easy.

The main objective of this project is to apply and develop a Lean system adapted to this restaurant to visualize all the problems and to present solutions to improve service and features the restaurant.

3.1 PROBLEM DEFINITION

This is a restaurant where customers have long waits from the moment they enter to the moment they leave. When there are a lot of people, the quality of service decreases and customers may not be completely satisfied.

3.2 CURRENT SITUATION

After having chosen the place to be studied, an observation of the service provided was made and a data collection was made in order to identify processes, movements, waste or the determination of the methodology used, among others.

The following study has been done in different services during the week. We have studied the midday service, meals, timetable from 13:00 to 16:30, but we must take into account the time spent in the morning organizing and preparing the restaurant for the service and the time it takes to pick up and clean up in the afternoon once the service has finished.

Only the orders of the "Daily Set Menu" have been taken into account, as it is the one that is most consumed at midday thanks to tourists and all the permanent clients of the country who go out to eat out either for work or for comfort. It is also necessary to bear in mind that the study made from the "Daily Set Menu" is the one that will provide us with a standard and is where we will really be able to see the errors made habitually and in this way we will be able to directly influence the problem. No study has been done at night as the volume of clients is more variable as the commands are also more varied and more difficult to set a standard.

The following is a description of the premises on which the work is to be carried out and the conditions under which it is to be carried out.

Application of lean management to the tourism, hotel and/or restaurant sector.
Cristina Crespo Guillermo

Type of premises (restaurant):

- Central area of the capital at 500m from the main avenue.
- Rectangular space of about 80 square meters.
- A single entry.
- Capacity for 70 diners.

Working conditions:

- Kitchen:
    - 2 Operators (cook and assistant)
    - 2 Sinks
    - 1 Stove area, 2 grills and 2 fryers
    - 1 Oven
    - 2 Microwave ovens
    - 5 Refrigerators
    - 1 Freezer
    - Bread cutting area
    - 4 Countertops
    - 2 Dishwashers
    - 1 Coffee machine (3 coffees simultaneously)
    - 1 Cash register machine
    - 8 Shelving units

- Dining room:
    - 2 Operators (Maître and waiter)
    - 16 Tables (37 diners)
    - 1 Kitchen tools Wardrobe, tablecloths, drinks
    - 1 Drinks fridge
    - 1 Fridge / freezer
    - 1 Bathroom
    - 1 Dressing room
    - Upper dining room stairs

- Upper dining room:
    - 9 Tables (30 seats)
    - 1 Bathroom
    - Costume Zone Workers
    - 3 Large cold stores
    - 3 Drinks and food store
    - 1 Bar
    - 1 Sink
    - 1 Drinks fridge

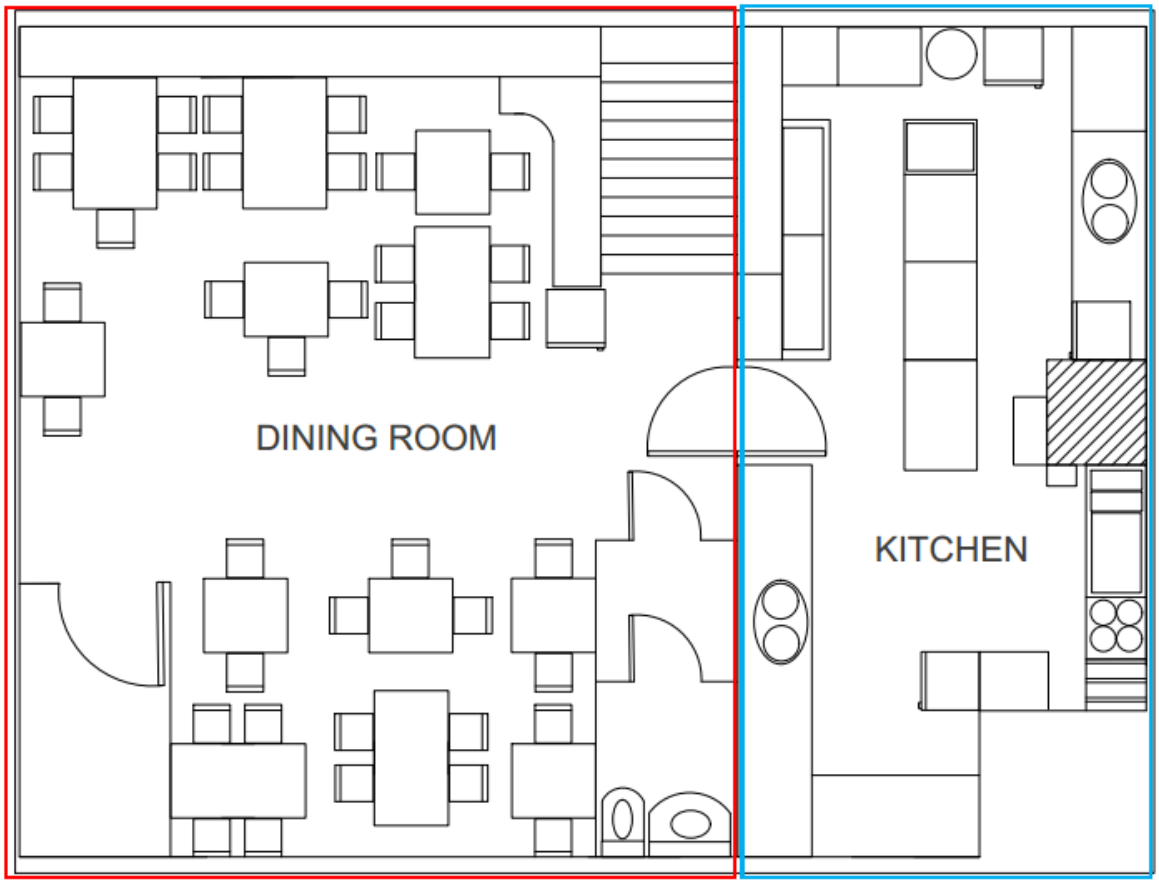


Figure. 9 Restaurant layout

Next, the KPI's are defined, the different indicators with which we will work divided into three phases that encompass the total cycle of the work:

KPI's Pre-Service:

1. Time to clean the dining room
2. Time to clean the toilets
3. Time to clean the entrance
4. Time to lay the tables
5. Time to recharge drinks fridge
6. Time to prepare the courses of the day
7. Time to prepare the first courses
8. Time to prepare the second courses
9. Time to recharge food fridge

KPI's during the service:

1. Time to sit down and accommodate clients
2. Time to take order since they have sat down
3. Time to serve the snacks to the customers
4. Time to serve drinks and bread
5. Time to pass the order to chef

6. Time it takes to serve the first course
7. Time to pick up the first course since the customer has finished.
8. Time to serve the second course.
9. Time to pick up the second course since the customer has finished.
10. Time it takes to order desserts and coffees.
11. Time making desserts and coffees
12. Time to serve desserts and coffees.
13. Time to make and bring the bill and collect.
14. Time it takes to clean the table from the moment the customer leaves
15. Time it takes to lay a table
16. Time it takes the cook to read the order.
17. Time to cook the first dishes
18. Time to cook the second dishes
19. Time it takes to put in the dishwasher
20. Time it takes to remove and dry the dishwasher

KPI's Post-Service:

1. Time to pick up and clean up the remaining tables.
2. Time to set up the remaining tables
3. Time to sweep
4. Time to recharge beverage coolers
5. Time to put in clean dishes
6. Time to take the trash out of bottles and cans
7. Time to clean the kitchen
8. Time to put in the dishwasher
9. Time to remove and dry the dishes from the dishwasher
10. Time to clean the sink + sweep + scrub
11. Time to recharge food coolers
12. Time to take out the trash.
13. Time to cash up the till

The following KPI's have also been taken into account in order to make the calculations better and the results more realistic:

A. Service capacity. Counting of tables served per service.
B. Distance covered by waiter. Measurement of the meters that the waiter makes during the service.
C. Hourly service errors.
D. Customer satisfaction. It is difficult to know the satisfaction of our customers, so it is a value that we will not work with, but it would be interesting to quantify it in order to give more veracity to our data.

3.3 ISHIKAWA DIAGRAM

The Ishikawa (Fishbone) diagram has been made, which consists of a graphic representation that allows visualizing the causes that explain a certain problem, which makes it a widely used tool of Quality Management since it guides the decision making process when dealing with the bases that determine a deficient performance.

In our case, the main problem is the Deficient Service provided in the restaurant, which is an effect of all the causes that make up the staff, procedures, supplies, products and environment as can be seen below.

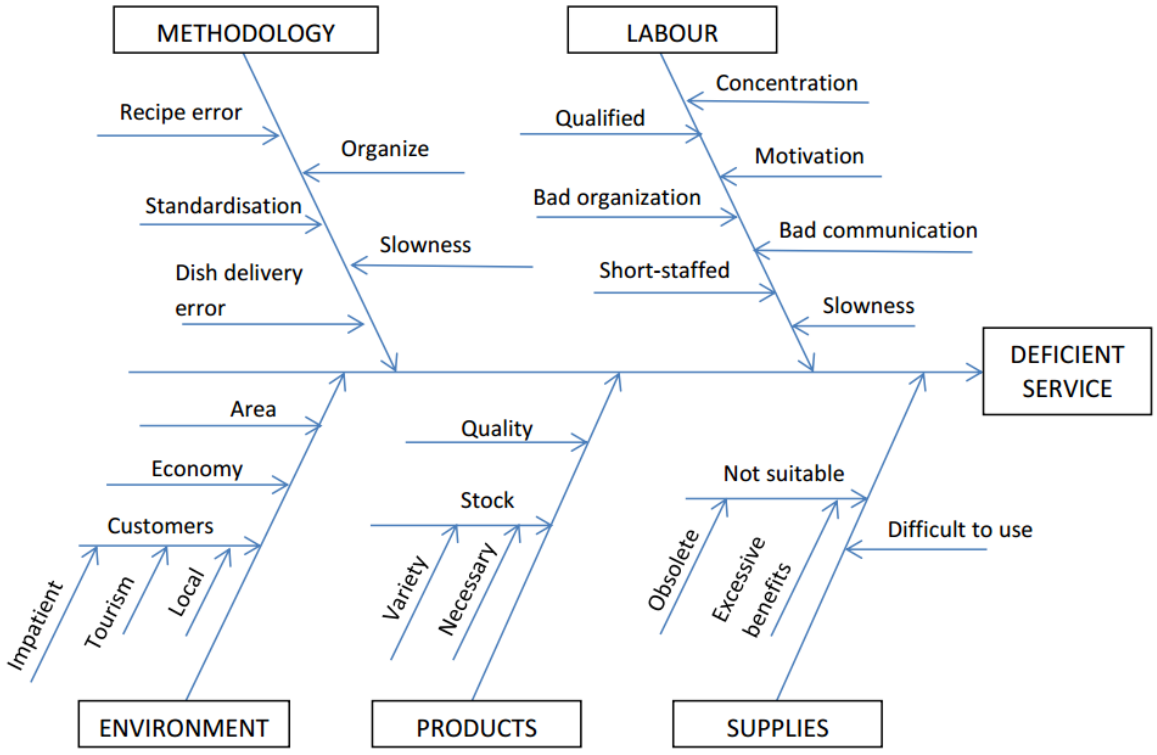


Figure. 10 Ishikawa diagram

As seen in the Ishikawa diagram of customer service in the restaurant, we can detect the main causes of poor service, in this case, the labour force and the methodology that are the most crowded branches. Through the whys and wherefores we will do the analysis of the diagram.

- Methodology:
  - Recipe error
    - Because the chef is not focused
    - Because the chef didn't notice the order
  - Standardization
    - Because the processes do not follow a methodology or an order
    - Because we work improvising, as we have always done
  - Dish delivery error

        - Because the cook does not understand the waiter's handwriting
        - Because they do not follow a delivery order and the waiter gets confused at the table
    - Order of the premises
        - Because the materials are not found because they are not in the correct order
        - Because the distribution and order of the premises has been done without thinking
    - Slowness
        - Because the cooks make the food without taking into account the taking into account the times on the different dishes
        - Because the cooks do not take into account the meal times of the customers

- Labour:
    - Qualified
        - Because there is a lack of training and evolution
        - Because untrained workers are no longer useful.
    - Motivation
        - Because they are not involved in the objectives of the company.
        - Because they are not given sufficient participation.
        - Because they only take orders and have no choice but to make their own decisions.
        - Because they do not receive an extra bonus for the work done.
    - Concentration
        - Because the workers are aware of other things that are not the chore.
        - Because they have personal concerns about some external factor and do not devote as much attention as they should.
    - Bad Organization
        - Because the shifts and roles of the workers are not well defined.
        - Because no standard working model has been created.
    - Short-staffed
        - Because it is a restaurant for a lot of capacity and the workers are not enough to cover it.
    - Bad communication
        - Because there is no simple and fluid communication between workers.
        - Because the communication between kitchen and dining room is done through paper and voice and the cook does not understand the waiter's handwriting.

- Environment:
    - Zone.
        - Because the area is two blocks from the confluence avenue.
        - Because it's not advertised anywhere.
        - Because they've opened a lot of restaurants around here.

- Economy
  - Because customers are the basis of the business and depending on them can generate more or less profit.
- Customers
  - Because if many people come in at the same time, the quality of the service can get worse.
  - Because the client requests the service according to his needs.
    - Tourism
      - Because there are fluctuations in customers.
      - Because an overloaded capacity can be generated.
      - Because it can lower the quality.
    - Local
      - Because they can stop coming because of the lower quality.
      - Because they are permanent customers and are looking for more personalized service.

- Products:
  - Product Quality
    - Because you buy low-quality products
    - Because there is a higher profit margin
  - High stock of products
    - Because it is cheaper to buy large lots
    - Because suppliers distribute in this way
      - Limited variety of products
        - Because there is not enough storage space
      - Required stock
        - Because you have to buy a lot of a product
        - Because the product that is not consumed is a loss

- Supplies:
  - Not suitable for the premises
    - Obsolete machinery
      - Because no investments have been made to improve it
      - Because they no longer fulfil the required functions
    - Excess benefits
      - Because we have invested in machines with advanced technology that are not useful in the restaurant
      - Because there was a good economic situation
  - Difficult to use
    - Because you don't know how some new machines work
    - Because they're used incorrectly

As a conclusion to this analysis, we can say that we will focus on finding solutions to the main priority problems. We will still take into account all the causes that have been specified.

3.4 VALUE STREAM MAP (VSM)

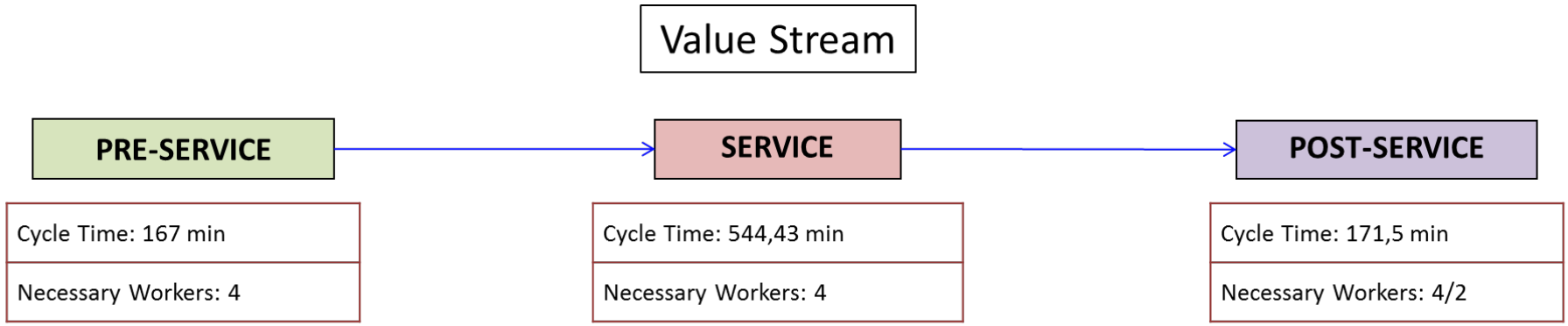
On the other hand, VSM is a graphic technique that allows you to visualize a whole process, allows you to fully detail and understand the flow of both information and materials needed for a product or service to reach the customer.

This technique identifies activities that do not add value to the process and then applies the necessary resources to eliminate them.

VSM is one of the most commonly used techniques to establish improvement plans, in our case customer service, being very precise because it focuses improvements on the point in the process from which the best results are obtained.

As it was a restaurant service analysis, the VSM diagram did not give us all the information we needed to develop our project, so we used the Swimlane diagram.

Below are a flowchart or Value Stream (Flow Diagram) and then the Swimlane diagram.



Pre-Service:

Operation 1:
- Prepare dishes
- Clean and tidy
- Recharged refrigerators

Service:

Operation 2:
- Sit down and record the order
- Give the chef the order

Operation 3:
- Serving snacks, drinks and bread

Operation 4:
- Server first dish

Operation 4.1:
- Collect first dish

Operation 5:
- Serve second dish

Operation 5.1:
- Pick up second dish

Operation 6:
- Serve desserts and coffees

Operation 7:
- Make and charge the bill

Operation 8:
- Clean and lay the table

Operation 9:
- Read the order
- Cook first dish

Operation 10:
- Cook the second dish

Operation 11:
- Orders and makes desserts and coffees

Operation 12:
- Dishwasher safe
- Remove and dry dishwasher

Post-Service:

Operation 13:
- Collect, clean, sweep and assemble
- Recharged refrigerators
- Putting on, taking out, drying and placing dishes
- Trash removal

Operation 14:
- Cash up the cash

Figure. 1 Flow diagra

3.5 SWIMLANE DIAGRAM (MAKIGAMI)

A Swimlane diagram (Makigami) is a visual tool used to show how a process flows from beginning to end. Each step is broken down in detail to determine what needs done, who is involved, and how goals will be met. This diagram, unlike the VSM, does not represent the flow of information.

By arranging various data elements into specific categories and showing how they function, Swimlane diagrams make it easy to see how efficient a process is and where improvements can be made.

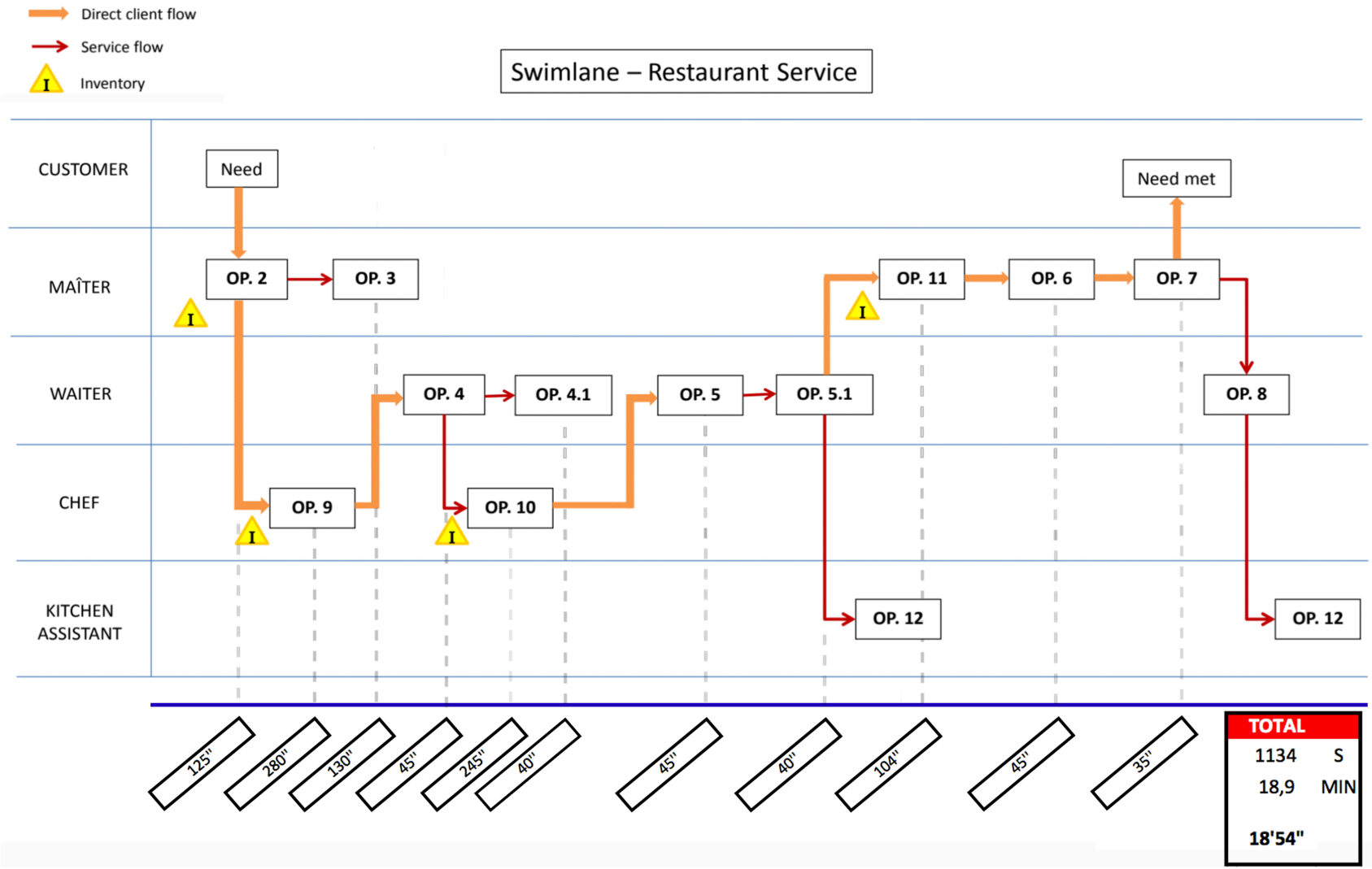


Figure. 1 Makigami

Operations during Lunch Service:

Workers	Maître	Waiter	Chef	Kitchen Assistant
Operations	Op.2, Op.3, Op.11, Op.6, Op.7	Op.4, Op. 5, Op.8	Op. 9, Op.10	Op. 12

Operations	Tasks	Operations	Tasks
Op.2	Sitting and accommodating customers Record the orders Give the chef the order	Op.11 Op.7	Order desserts and coffes Make desserts and coffee The bill €
Op.3	Serve snacks Serve drinks and bread	Op.8	Clean the table Lay the table
Op.4 Op. 4.1	Serve first dish Pick up first course	Op.9	Read the order Cook the first courses
Op.5 Op. 5.1	Serve second dish Pick up second course	Op.10	Cook the second courses
Op.6	Serve desserts and coffes	Op.12	Put the dishwasher Remove and dry the dishes from the dishwasher

Figure. 2 tasks distribution

As shown in the diagram above, it has been divided into five sections or roles: the customer, the maître (head waiter), the waiter, the chef and the kitchen assistant.

The entire diagram is based on the customer's need from the moment he enters the door until his need is met.
In this way we can see who performs each operation and the flow they take.
The orange lines mark the direct path of the main need that is food. The red lines indicate the remaining flow indirectly influencing the customer's need to meet.

Swim lane diagrams are excellent tools for laying out, step by step, how a process should flow. When looking for areas of improvement, they make it easy to identify problems and what caused them.

When used effectively within an organization like a restaurant service, swim lane diagrams can clearly define what each area does, and who holds responsibility.

3.6 SPAGUETTI CHART ANALYSIS

A spaghetti chart diagram is the representation of how the movement of the operators is within their workstation, it seeks to know each movement of the employee in order to later look for which is the most logical order for machines, cabinets, other workstations and gain in efficiency within the company, first of all reducing operator travel time and increasing production performance.

The spaghetti chart of the route that the waiters and cooks make during the midday service has been realized. In this way we can detect unnecessary displacements or points where bottlenecks are created and eliminate them.

A layout of the restaurant's dining room and kitchen (work area) has been drawn up and lines have been drawn according to the movements made by the operators throughout the process. The result is a set of many mixed lines that define the path of the operators. The measurements of the distances and the elements have been made as close to reality as possible.

In this way, we can visualize the different routes taken by waiters and cooks during the service and thus analyze the movements and the meters covered. Times and interruptions in different cycles or processes have also been taken into account.

The layout of the premises is already defined without taking into account all the processes or the method of all the activities that are carried out, which causes effects on them. Surely if all the processes were correctly defined first and then the construction of the space from them was done, the distribution would be the adequate one and probably many unnecessary displacements would be avoided.

In order to carry out this study correctly, different spaghetti chart diagrams have been made in the same time zone of several days. None of these diagrams coincide with each other as the activities are totally random but they do have a pattern of meeting the

needs of the clients, which is to feed them.

The diagram is based on the observation of the complete service to a specific customer. From the moment the client enters through the door to eat until he leaves through the door again, having covered his needs.

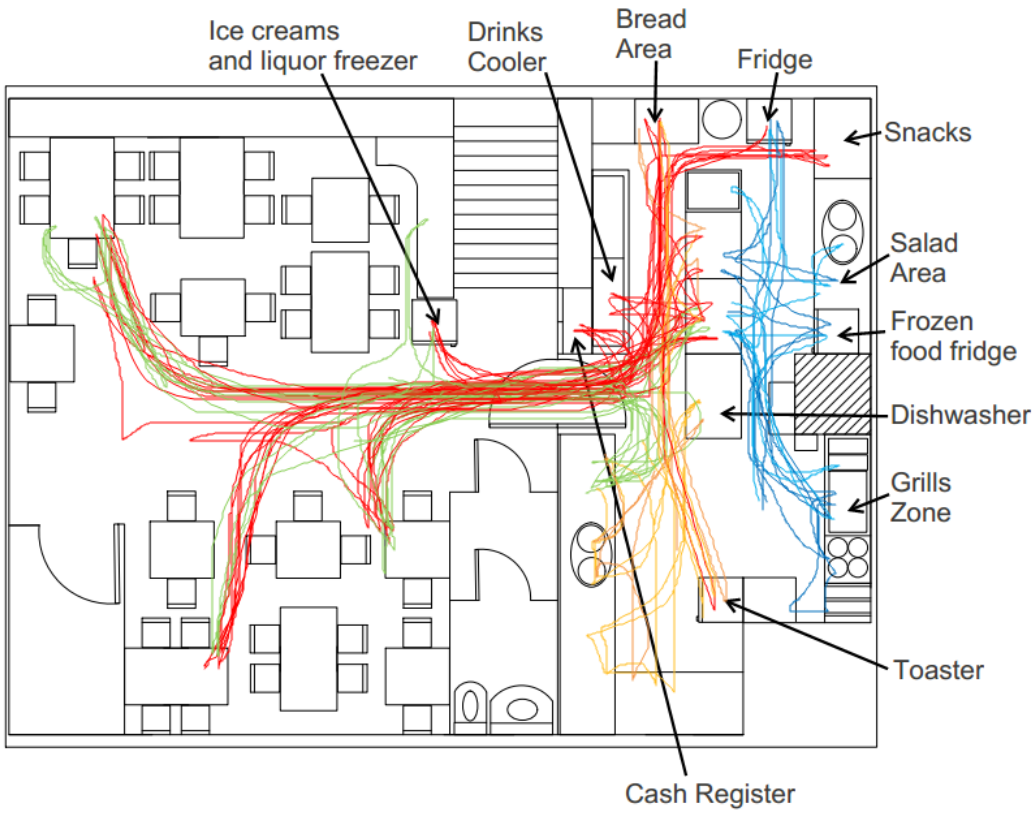


Figure. 14 Initial spaghetti chart

The red lines represent the movements of the head waiter (Maître) and the green lines represent the movements of the waiter in the dining room and kitchen.
The blue lines represent the movements of the chef and the orange lines represent the movements of the kitchen helper.

As can be seen in the diagram above, there are some undefined tasks and it is not known who does them, in these cases we find overlapping tasks.

The entrance to the kitchen is a confluence point because as you can see there are many crossroads of lines which mean crossroads of movements of the head waiter (Maître) and the waiter which can lead to collisions, slower movements, etc.

It is also observed that the door that accesses the wardrobe and the bathroom are very close together and there can be collisions between waiters and customers, which can lead to inefficiencies in the service.

Many of the movements performed during the service do not follow a predetermined route. If we pay attention to the service, we see how the waiters move around where

they want without thinking about which way is the shortest. Sometimes they also don't take advantage of going back and forth to the tables one hundred percent, which we could define as extra trips, totally unnecessary.
For example, the waiter serves the dishes to a table and goes back to the kitchen without picking up the dishes from the next table that they have already finished eating and has to come back later.

The location of some of the kitchen machines also does not follow a logical order, such as the bread toaster, which is not in the same area of the bread where the loaves are stored, cut and served in bread baskets. Each time the kitchen assistant have to make toast, he has to go to the bread area, cut it, bring it to the toaster and when it is toasted put it in a bread basket.

The waste observed during the service can be classified according to the type defined by the Lean methodology.

As we have said before, transport waste has been found above all. These are all the movements of products that do not bring any added value. Bringing drinks from the kitchen to the table is necessary, but this does not increase the value of the product, so it is considered a waste. In every customer service we find this waste constantly, but in our case, obviously, we cannot eliminate it but we can try to reduce it to the maximum.

Less often we see waste of movement. They are all those displacements that the waiter does without sense, displacements by the dining room without contributing anything to the service, turns around the tables without taking anything. Usually these actions are the result of a waiter with little experience or motivation for his work. Based on a working pattern, this waste should be reduced.

To find out how far the waiters were walking, we put an activity bracelet (pedometer) on them, so that we could see the total steps they were taking and the distance they were walking during the meal service. The approximate average distance we obtained was 1040 meters.

Finally we identified re-process waste. This waste is the result of mistakes with orders, when the chef does not understand the waiter's letter and cooks another dish different from the one the customer has asked for and then has to do it again, when the chef makes a mistake with the recipe and has to do it again or when a waiter collides with a customer at the entrance of the kitchen and bathroom and the dish falls down and the chef has to do it again. These wastes are not many in quantity but they do create a significant imbalance in the work chain. The lack of concentration, motivation and an effective working method has an impact on the appearance of this waste.

3.6.1 Measures taken and situation proposed.

Once we have analysed the problems, we give them a solution by taking the necessary measures. The 5S application will be useful to put order in the whole service.

To carry out this implementation, follow the 5 steps below:

1st step. Seiri (Sort).

We look at everything in the restaurant, both in the dining room and in the kitchen, from the toaster to the mop, and wonder whether it is useful or not, that is, whether we use it or not. We separate all things into two groups: those that are used and give service and those that are of no use to us. The latter we can say that they do not contribute anything to the operation of the restaurant and therefore we can eliminate them.

Now we have to divide the things in the first group into two more groups: the things we use very often (such as a coffee maker or a bread cutter) and the things we use from time to time (such as a broom or a blender). In the next step we will see how to put all these things in place.

To know what to do and where to order each item we will use the red cards. These cards serve to identify the problem detected and the proposed action to solve it. An example of a red card is shown below.

Num. 1	Area: Planner	5S LABEL			Date: mm/dd/yyyy
Problem detected	Blender Location				
Proposed action	1. Eliminate			5. Signalize	
	2. Eliminate. Pending decision			6. Cleaning	
	3. Sort		X	7. Repair/Improve	
	4. Identify			8. Standardize	
	Other (define):				

Figure. 15 Red Card. 5S working tool

2nd step. Seiton (Set in order).

After you have done the layout in step 1, it is now time to put everything in its place. According to the previous step, you have to place the things that are frequently used in the places that you have closer, almost immediately and the things that are used less to keep them in less accessible places.

It is very important that all things are located near the site that are useful. For example the toaster nears the bread or the cups near the coffee maker or the tablecloths near the tables to avoid large displacements.

To avoid conflicts and to help workers know where things are located it is very useful to put up signs indicating where things are located. It will be easier for workers to remember where things are and they will have no doubts. Images or help procedures can also be placed on the placards for ease of comprehension.

3rd step. Seiso (Shine).

This step is based on cleaning, removing all the dirt from the restaurant with the right products. Sweep and scrub the floor, clean the grill, clean the bathroom, etc.

The whole restaurant has to be cleaned in general way. For this purpose, a detailed document will be drawn up on how to clean each area, with which products, which steps must be taken and what level of requirement is to be achieved.

This cleaning plan will also include how often the cleaning action has to be performed, at what time of day, who is in charge of it, the rules and steps to be followed, what the final result should be and how long it should take to perform this action.

For example: the cleaning of the restaurant entrance. The waiter will do this action during the morning cycle. He should take the window wiper and a yellow cloth to clean the door and windowpanes. He should apply a few drops of glass cleaner to the surfaces and then wipe everything thoroughly with the yellow cloth without leaving any marks or stains. Once you've finished cleaning, you'll put the window cleaner and the yellow cloth back in their place. He then takes the broom, sweeps the entire entrance from front to back and collects the dirt with the dustpan. You will throw the dirt in the trash and put the broom and dustpan back in their place.

Therefore, in this case, the most useful thing would be to have a cleaning plan that includes all the aspects and steps to follow in the cleaning process mentioned above.

4th step. Seiketsu (Standardize).

In order to achieve standardization, the three previous steps (Seri, Seiton and Seiso) must be integrated into the daily routine of the restaurant workers and their work habits. Organization, order and cleanliness must be maintained.
It should be noted that this standardisation couldn’t remain stagnant either and must evolve and improve with the passage of time and the help of workers.
The workers are the ones who will be able to suggest new proposals for improvement or detect small mismatches since they are the ones who will apply this standard continuously.
Therefore, meetings should be held periodically to express new proposals for evolution and to add them to the cleaning plan that was initially created.

5th step. Shitsuke (Sustain).

At this point, the steps previously applied must be maintained. There is no standard or norm that requires this compliance so we will have to rely on the effort, the acquisition of these habits and the will to do so.
If we do not achieve compliance with the previously applied steps, the 5s will deteriorate in a short time.

For this reason, it is important to encourage employees to apply the standard as well, and demonstrate them how to do so. You can also put up before and after photos of the implementation of the standard or make periodic evaluations of the workers to encourage motivation among them.

From the spaghetti chart we could see how the distribution of the kitchen machines was not the most appropriate and the cooks had to go through a lot of rounds to find things and cook the dishes. With the application of the 5S, a new kitchen layout has been created, making the work easier and bringing the things that are used together closer together. Tools that are used from time to time have been stored in less accessible places.

We also observed how the roles of each worker were sometimes confused and unclear as the two waiters (Maître and waiter) might be serving the same table or doing two similar activities simultaneously when they could do just one thing. As a consequence, we can observe all the lines that cross in the dining room and above all at the entrance to the kitchen, so from the application of the 5s we have defined that the head waiter (Maître) is only dedicated to attending to the activities that do not require entering the kitchen and that the other waiter is in charge of entering and exiting and serving the dishes to the tables. In this way we will also avoid collisions between them when entering and leaving the kitchen.

Continuing with the issue of personnel collisions, we also observed the limited space between the bathroom door and the kitchen and the fact that it causes collisions between customers and waiters. To improve this point it has been decided to incorporate a porthole in the access door to the wardrobe and bathroom so that customers can see from the inside if there are people at the entrance of the kitchen.

On the other hand, we could see that commands sometimes the letter is not understood. This can cause the chef to get confused about dishes and delay customer service. To improve this point it has been decided to incorporate PDAs to write the commands of the clients and to reproduce them orderly in the kitchen through touch screens and computers. This incorporation also helps the head waiter (Maître) to prepare the bill for the customers and prevents him from entering the kitchen, so he also moves less.

The new Spaghetti chart is shown below once the 5s have been applied.

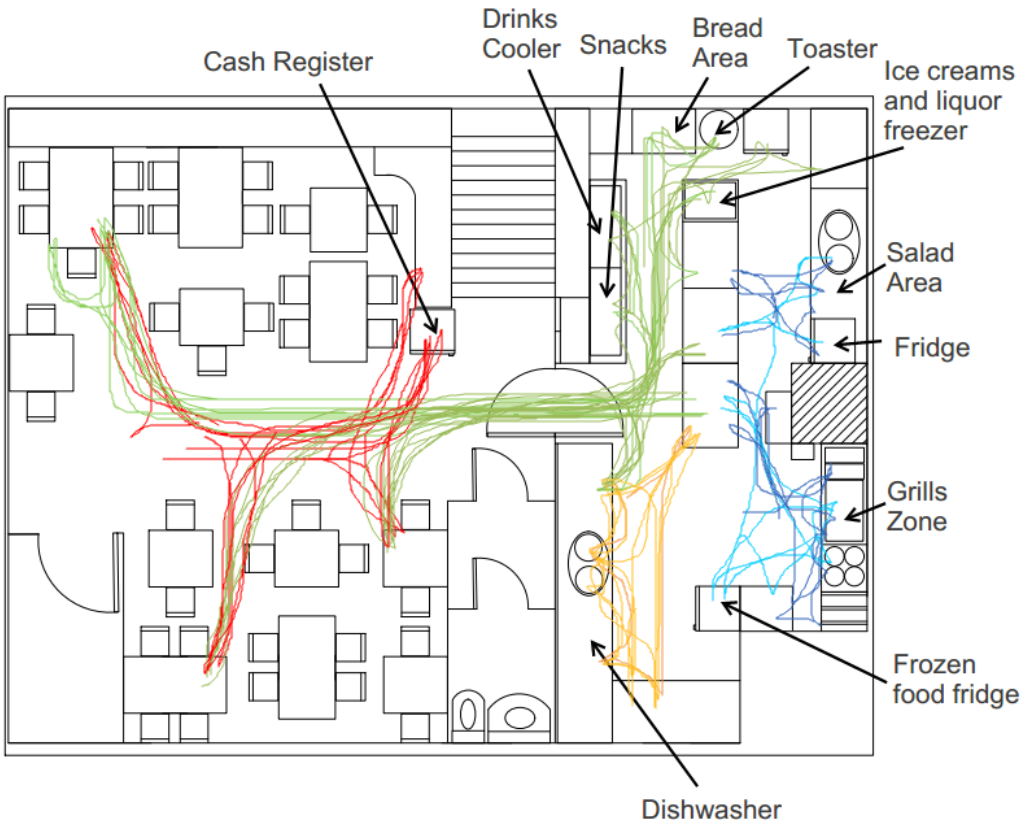


Figure. 16 final spaghetti chart

It is observed that with the new distribution the roles of each worker are better identified and the work zones are better detected. We can see how the workers practically don't cross each other, except the waiters. It is also noted that the head waiter (Maître) does not enter the kitchen at any time and placing the cash register in the dining room reduces movement and waiting times.
With regard to the kitchen, four areas can be clearly distinguished: the area for cooking cold dishes, the area for cooking hot dishes, the area for bread, drinks and snacks and the area for cleaning and dishwashing. The chef and the kitchen assistant don't cross at any time.

With the new distribution, the number of metres travelled by waiters during the service has been reduced by almost 40%. They would now cover a distance of approximately 623 metres.

Obviously, this working methodology should be applied, needs assessed and improvements proposed in order to continue evolving.

In the following section the real study has been made from the data and real times of the service in the restaurant.

4. STUDY OF THE DATA

4.1 ANALYSIS OF THE DATA

From the Swinlane diagram, the spaguetti chart and the five-day data collection at the restaurant we have done the following study.

All tasks that are performed before, during and after the service to satisfy the customer with respect to a dinner table have been detected.

These tasks are divided into cyclics and acyclics. The cyclic work corresponds to those tasks that are performed during the meal service, ie, those that provide a direct value to the customer such as serving the drink or making a coffee but not counting the machine times.

On the other hand, the acyclics include all the tasks that are carried out in this case before and after the meal service. These are those tasks that are necessary to be able to perform the meal service such as cleaning the kitchen or preparing the tables, but they are not activities that directly influence the customer.

Machine times are also not taken into account for these tasks. Mistakes made during meal service, such as mistaking a recipe for a dish, are also seen as acyclic in the study.

As can be seen from the Swimlane diagram, all the tasks that workers perform in different operations have been grouped together to make it easier to understand and distribute tasks.

Five main roles have been identified: the client, the headwaiter (Maître), the waiter, the chef and the kitchen helper. Each character has been given the different operations and from the times taken during the study of several days has been calculated an average of times per table.

The data collection has been done based on a table since the operations are carried out per table independently of the diners who occupy them.

In total, an average of 43 diners have been counted in a meal service, which corresponds to the use of approximately 14 tables, so the times have been divided among the 14 tables occupied to find the average time per table.

Thus, if we count 43 diners among 14 tables, the result is 3,1 diners per table.

Below is a list of the selected operations performed by each restaurant worker.

Workers	Maître	Waiter	Chef	Kitchen Assistant
Operations	Op.1-M Op.2 Op.3 Op.11 Op.6 Op.7 Op.13-M Op.14-M	Op.1-W Op.4 Op. 5 Op.8 Op.13-W	Op.1-C Op. 9 Op.10 Op.13-C Op.14-C	Op.1-A Op.12 Op.13-A

Figure. 17 Operations per worker

- –M → Maître
- –W → Waiter
- –C → Chef
- –A → Kitchen Assistant

List of operations with their associated tasks:

Operations	Tasks
Op.2	Sitting and accommodating customers
	Record the orders
	Give the chef the order
Op.3	Serve snacks
	Serve drinks and bread
Op.4	Serve first dish
	Pick up first course
Op.5	Serve second dish
	Pick up second course
Op.6	Serve desserts and coffees
Op.11	Order desserts and coffees
	Make desserts and coffee
Op.7	The bill €
Op.8	Clean the table
	Lay the table
Op.9	Read the order
	Cook the first courses
Op.10	Cook the second courses
Op.12	Put the dishwasher
	Remove and dry the dishes from the dishwasher

Op.1-M	Clean dining room
	Lay the tables
	Recharge beverage coolers
Op.1-W	Clean the toilets
	Clean the entrance
Op.1-C	Prepare the dishes of the day
	Prepare first courses
Op.1-A	Prepare the dishes of the day
	Prepare second courses
	Recharge food coolers
Op.13-M	Lay the tables
	Sweep up
	Take out the trash (bottles and cans)
Op.13-W	Pick up and clean the tables
	Recharge beverage coolers
	Place the cleans dishes
Op.13-C	Clean the kitchen
	Take out the trash
Op.13-A	Put the dishes in the dishwasher
	Remove and dry dishes from the dishwasher
	Clean the sink, sweep and scrub
	Recharge food coolers
Op.14-M	Cash up the cash
Op.14-C	Cash up the cash

Figure. 18 Operations with their associated tasks

Once we have selected the operations carried out by each worker, we have made the data collection to know the times that are used in the working day.

We have divided the working day into three parts: the pre-service, the service and the post-service.

The following topics are included:

- **Work-cycles**: time cycles into which the workday is divided.
- **Tasks:** activities carried out during the work cycles.
- **Replays:** number of times the same activity is repeated.
- **Time Frame**: time it takes to perform the same activity.
- **Total:** total time it takes to perform the same activity a number of times.

As we have already said, the calculations have been made using a dining table as a reference point.

So we have also calculated the time (in minutes) per table that waiters and cooks spend during meal service.

Work cycles into which we have divided the working day:

- **Cyclic**:
  - Morning cycle (11:00 - 13:00 hours)

- **Acyclic**:
  - Lunch cycle (13:00 – 16:00 hours)
  - Afternoon cycle (16:00 – 17:00 hours)

Example table of the cyclic and acyclic calculations:

WORKS CYCLES	TASKS	REPLAYS	TIME FRAME	TOTAL
Morning cycle (11:00 - 13:00) **Lunch cycle** (13:00 – 16:00) **Afternoon cycle** (16:00 – 17:00)	Task 1			
	Task 2			
	WAITERS TOTAL			
	Task 1			
	Task 2			
	CHEFS TOTAL			
TOTAL CYCLES (Morning + Lunch + Afternoon)				
TOTAL WORKING TIME				

Figure. 19 Example of calculation table

See Annexes I for complete tables of cyclic and acyclic calculations.

Below is a summary table of the times according to the cycles and corresponding tasks of each restaurant worker.

CYCLES	OPs.	TASKS	TIMES	TOT/TABLE (SEC/14)
Lunch time (13:00 – 16:00)	Op.2	Sitting and accommodating customers	40	125
		Record the orders	55	
		Give the chef the order	30	
	Op.3	Serve snacks	60	130
		Serve drinks and bread	70	
	Op.4	Serve first dish	45	85
		Pick up first course	40	
	Op.5	Serve second dish	45	85
		Pick up second course	40	
	Op.6	Serve desserts and coffes	45	45
	Op.11	Order desserts and coffes	24	104
		Make desserts and coffee	80	
	Op.7	The bill €	35	35

	Op.8	Clean the table	80	175
		Lay the table	95	
	Op.9	Read the order	50	280
		Cook the first courses	230	
	Op.10	Cook the second courses	245	245
	Op.12	Put the dishwasher	130	180
		Remove and dry the dishes from the dishwasher	50	
Morning cycle (11:00 – 13:00)	Op.1-M	Clean dining room	1200	167,14
		Lay the tables	120	
		Recharge beverage coolers	1020	
	Op.1-W	Clean the toilets	1800	171,43
		Clean the entrance	600	
	Op.1-C	Prepare the dishes of the day	1200	171,43
		Prepare first courses	1200	
	Op.1-A	Prepare the dishes of the day	600	205,72
		Prepare second courses	1080	
		Recharge food coolers	1200	
Afternoon cycle (16:00 – 17:00)	Op.13-M	Lay the tables	630	143,57
		Sweep up	600	
		Take out the trash (bottles and cans)	780	
	Op.13-W	Pick up and clean the tables	1260	197,14
		Recharge beverage coolers	900	
		Place the cleans dishes	600	
	Op.13-C	Clean the kitchen	1800	141,43
		Take out the trash	180	
	Op.13-A	Put the dishes in the dishwasher	300	192,86
		Remove and dry didishes from the dishwasher	720	
		Clean the sink, sweep and scrub	900	
		Recharge food coolers	780	
	Op.14-M	Cash up the cash	420	30
	Op.14-C	Cash up the cash	420	30

Figure. 20 summary table

Once we have made the calculations corresponding to the tasks that the restaurant workers perform per dining table, we have been able to know the time that each worker spends per table, both in the lunch service and in the pre and post lunch service.

Works Cycles	Workers	Time/Person(H)	Time/ all Tables(H)	Time/ 1 Table (min)
Lunch	M / W	1,74	3,47	13,06
	C / A	2,80	5,61	11,75
Morning	M / W	0,66	0,09	5,64
	C / A	0,73	0,10	6,28
Afternoon	M / W	0,72	0,10	6,17
	C / A	0,71	0,10	6,07

Figure. 21 Results table

So we can say that during the meal service the waiters spend about 13 minutes per dining table while the cooks spend about 12 minutes per table.

In order to better analyse these results and to reflect the functioning of the restaurant and its employees, we have produced some Pareto charts.

First of all we have made a diagram of the times of each operation per table. With this diagram you can see which operations are the longest, that is to say, the ones that take the most time and which are the fastest to do.

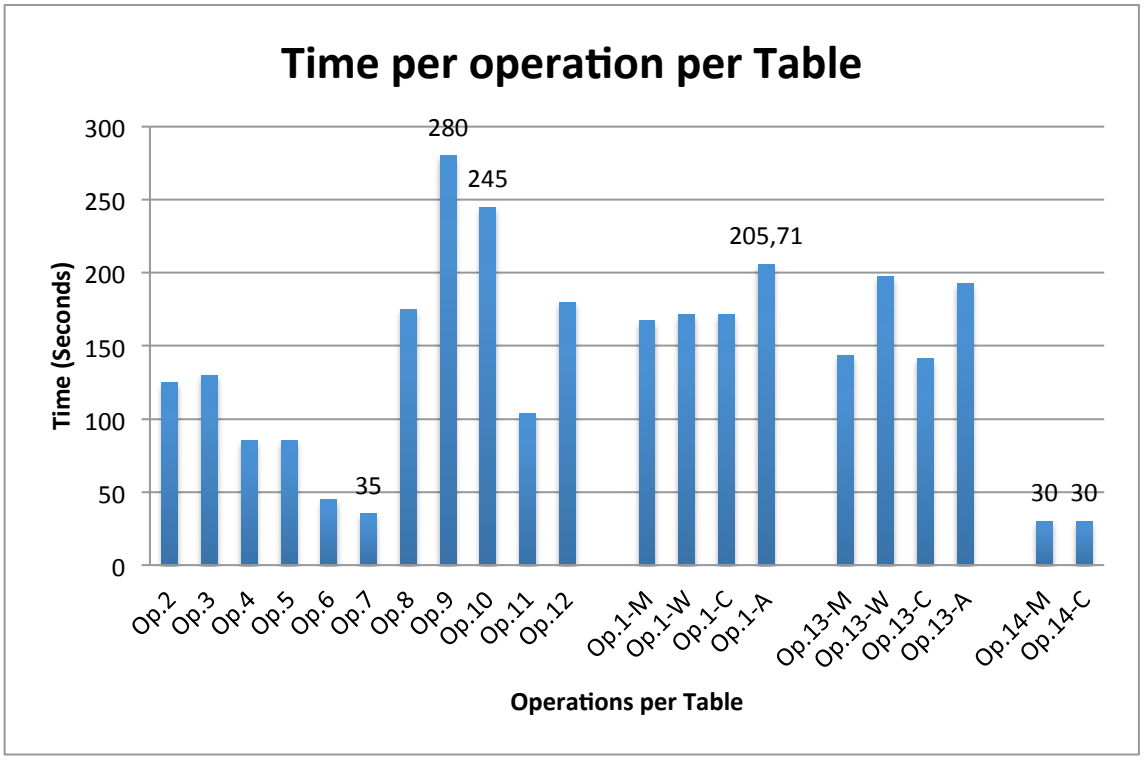


Figure. 22 Time per operation per table

After looking at the chart you can see how the operations Op.9, Op.10 and Op.1-A are the longest and most time-consuming.

On the other hand, Op.14-M, Op.14-C, Op.6 and Op.7 are the shortest and least time consuming operations.

The longest operations that take the longest time are those that include cooking the dishes and the shortest are those that have to do with the bill.

From here we have counted the times of the operations that correspond to the work cycle and those that correspond to the a-cycles according to each worker in the restaurant.

Operator	Cyclic Time	Acyclic Time	Total
Maître	439	340,71	779,71
Waiter	345	368,57	713,57
Chef	525	342,86	867,86
Kitchen Assistant	180	398,57	578,57

In the Pareto chart below we have compared the work cycles with the a-cycles to know the actual total time employed per dining table for each worker in the restaurant.

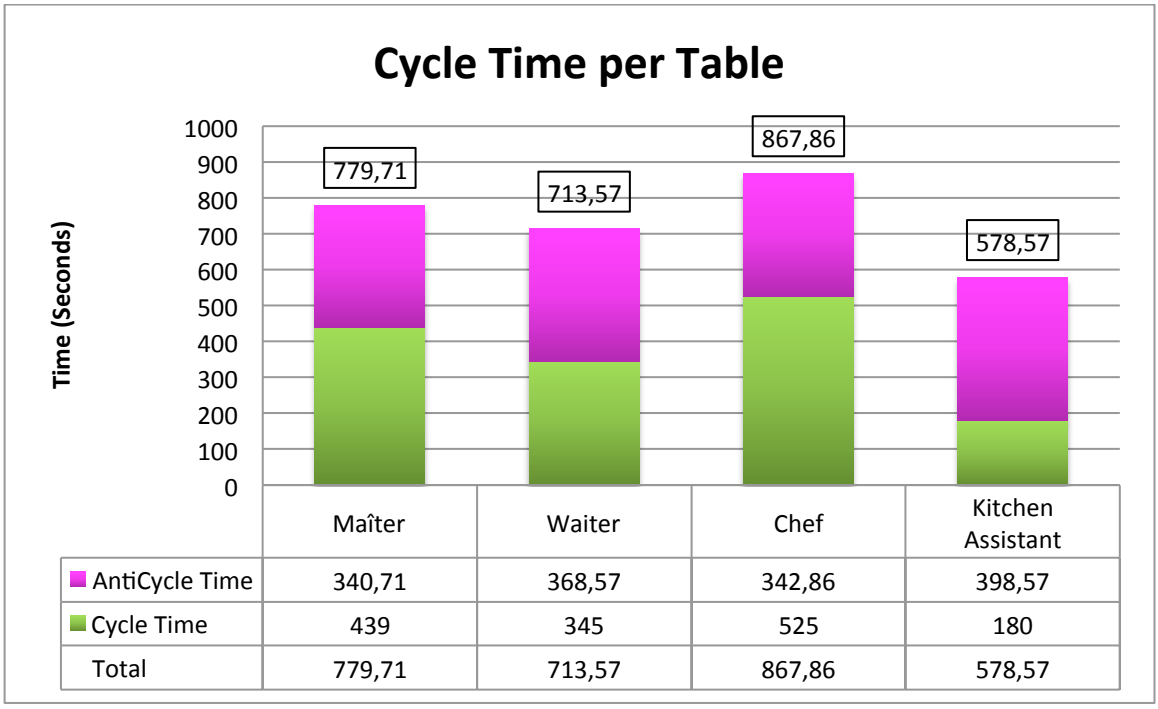
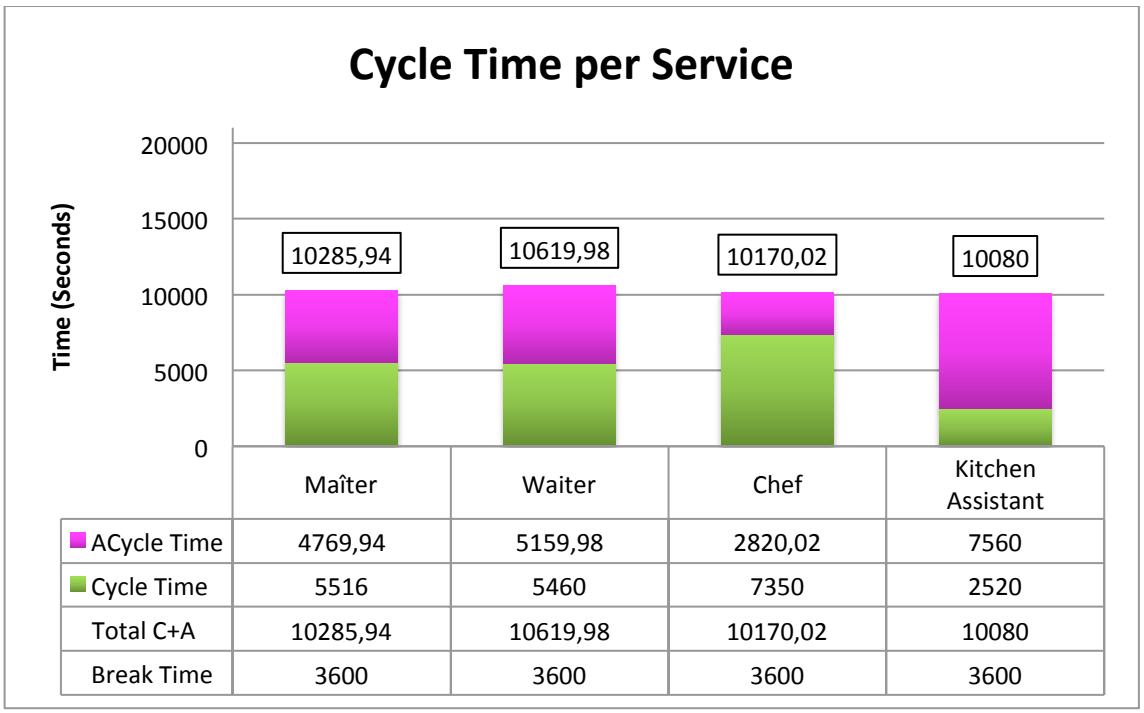


Figure. 23 Cycle Time per Table

It is observed that the chef is the worker who spends the most time per table, with the kitchen assistant being the least. It should be noted that the times used by the waiters are quite the same.

By making a new distribution of tasks and knowing how much time is spent on a task per table, we will be able to match these results.



	Maître	Waiter	Chef	Kitchen Assistant
ACycle Time	4769,94	5159,98	2820,02	7560
Cycle Time	5516	5460	7350	2520
Total C+A	10285,94	10619,98	10170,02	10080
Break Time	3600	3600	3600	3600

Figure. 24 Cycle time per service per all tables

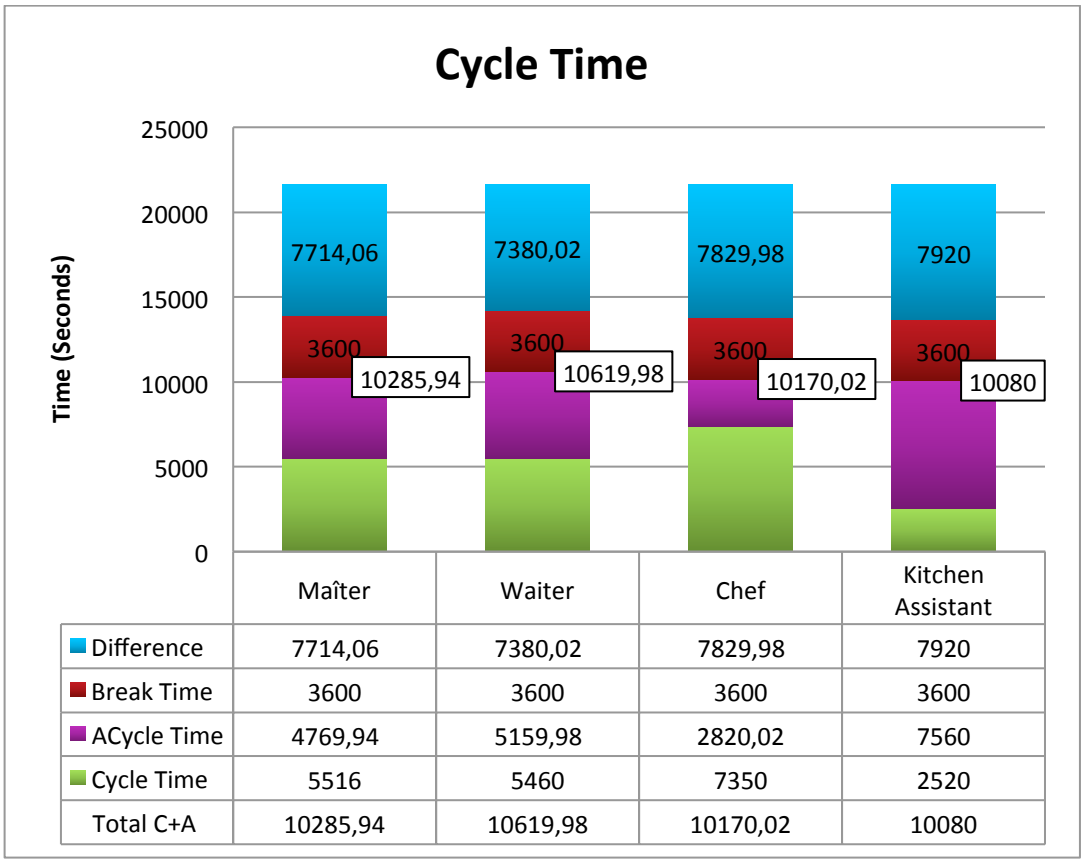
As we can see in the graph above, the tasks have been redistributed so that the four workers now spend the same amount of time per service and consequently per table approximately.

To achieve this equalisation, two tasks of the head waiter (Maître) and the chef, respectively, have been assigned to the waiter and the kitchen assistant.

The task previously performed by the Maître and now by the waiter is the Op.6 (Serving desserts and coffees) which corresponds to a time of 45 seconds. This task has no complications and we believe that since the waiter is in charge of serving the rest of the dishes on the menu, he can also be in charge of serving the desserts and coffees to the customers.

On the other hand, the task previously performed by the chef and now performed by the kitchen assistant is the Op.13-C (Clean the kitchen and take out the garbage) which corresponds to a time of 141 seconds: 2,2 minutes. In this case we have preferred that the chef continues to do the cooking functions as he is the expert in cooking and that the kitchen assistant is in charge of more acyclical functions such as picking up, cleaning and taking out the rubbish.

Next, another Pareto chart has been made showing the times each worker uses in a full working day (from 11am to 5pm). In addition to the cycle and a-cycle times, this chart includes the workers' meal times and the time remaining until they reach 6 hours of work per day.



	Maître	Waiter	Chef	Kitchen Assistant
Difference	7714,06	7380,02	7829,98	7920
Break Time	3600	3600	3600	3600
ACycle Time	4769,94	5159,98	2820,02	7560
Cycle Time	5516	5460	7350	2520
Total C+A	10285,94	10619,98	10170,02	10080

Figure. 25 Cycle time chart total

The time remaining called the difference in the graph corresponds to the time spent buying and placing the products, attending to suppliers, going to the bank, going to the dry cleaner's to wash the tablecloths, etc.

All these tasks fall within the workday as they are necessary actions to be able to carry out customer service, even though they do not provide direct value to the customer.

We wanted to do this redistribution of tasks so that all workers spend the same amount of time to be able to invest part of the time "difference" by attending more tables, increasing capacity. If we manage to free up more tables, more customers will enter and thus increase the work capacity and therefore the profits. For this to happen it is necessary that all the times of all the workers are balanced.

4.2 INCIDENTS DURING THE SERVICE

During the working day there may be incidents or actions that interrupt the tasks that workers are doing.

A "mistake" can be defined as any defect occurring during the process. In a restaurant service, there are many possible situations of error. Therefore, the application of Lean Manufacturing to the restaurant working requires total management of these mistakes

In this study, we evaluated the frequency and types of mistakes found in the restaurant.

Below are the largest or most frequent incidents that occur during meal service, as in our case it is the most critical because it directly influences customer service.

Incidents during the service		
Mark	Mistakes	Lead times
A	The waiter comes out of the kitchen and bumps into a customer who comes out of the bathroom and the dish spills out. The waiter has to go back to the kitchen and have another dish served.	2'
B	In the middle of the serving cycle, clients asked for the wiffi password even though it is marked on a sign.	0,5'
C	The course is given to the customer and he wants the meat more cooked. The waiter takes the dish back to the kitchen for the chef to make the meat more cooked.	1,1'
D	The chef does not understand the words of the order and makes a dish that is not the correct. The chef has to re-cook the right dish.	3'
E	The waiter is in the kitchen preparing a dish for a table and goes out to the dining room to say goodbye to other customers.	1'

Figure. 26 Table of Incidents

In order to be able to take these incidents into account in the study, we have counted them by frequency, as they are very small time incidents that happen from time to time, not every day.

Mark	Frecuency	Percentage	Time (sec)
A	2;70	2,9%	3,43
B	3;70	4,3%	1,29
C	20;70	28,6%	18,86
D	10;70	14,3%	25,71
E	20;70	28,6%	17,14

Figure. 27 Table of results of Incidents

In order to calculate the percentage of incidents and the time involved, a frequency has been estimated.

This frequency is calculated on the basis that in one week 70 tables are served on average (5 working days for 14 tables per day = 70 tables per week). The percentage of this frequency has then been calculated in order to know the corresponding time.
To obtain the time, the minutes of a task that fails have been counted by the number of times it fails every 70 tables.

For example, to calculate the time of the incidence A the 2 minutes that the waiter has lost in returning to the kitchen to get another dish per the frequency of this incidence have been counted. As the times are very short, they have been calculated in seconds.

Example:

2 minutes of a task that fails 2 times every 70 tables.

2 x 0,029 = 0,057 minutes = 3,4 seconds.

Then, in the Lead Time of table service, you have to add 3,4 seconds.

Thus, in the total Lead Time of a table service, all the times of the calculated inefficiencies must be added to it.

This total time of inefficiencies, A+B+C+D+E= 3,43+1,29+18,86+25,71+17,14 = 66 seconds = 1,1 minutes. Since these are such short times, we will look at them within the daily time frame that workers have during their working day to perform cleaning tasks, organize the stock, among others.

Most mistakes occurred between the kitchen and the dining room this suggests that co-operation between both zones is still the key to improvement of restaurant quality.

By other hand, it will be important to define the operations of all members of the restaurant to guarantee that all the steps are completed and the diner will be satisfied.

4.3 STUDY OF SUPPLIERS AND STORAGE

In order to carry out the study on the storage and suppliers of the restaurant, first of all we had to count how many different dishes are consumed per day and which the preferred ones by the customers are.

All orders placed within five working days have been counted. In total about 216 dishes approximately.

From this study we will also be able to know the preference of the clients and see which dishes of the day's menu could be suppressed and which should be kept. This is a way to save money and optimize processes.

Below we have a table showing all the dishes that enter the menu of the day, first courses, second courses and desserts and the number of times they have been ordered in 5 days. We have taken the percentage of these orders to begin to intuit which are the most requested and which are the least requested.

	Ref.	Dishes	no. of orders	no. of orders	no. of orders	no. Of orders	no. of orders	Percentage %	TOTAL	Sigma	Mu	Variab.(%)
First courses	1.1	Mixed salad	8	7	9	8	9	19,07	41	0,84	8,2	10,24
	1.2	Macaroni	8	6	7	5	4	13,95	30	1,58	6	26,33
	1.3	Duck pate	3	5	6	4	6	11,16	24	1,3	4,8	27,08
	1.4	Soup	9	7	4	3	2	11,63	25	2,92	5	58,4
	1.5	Croquettes	5	4	4	6	8	12,56	27	1,67	5,4	30,93
	1.6	Stuffed peppers	2	1	3	8	6	9,3	20	2,92	4	73
	1.7	Ham toast	5	6	3	3	6	10,7	23	1,52	4,6	33,04
	1.8	Day dish 1.8	3	2	2	2	4	6,05	13	0,89	2,6	34,23
	1.9	Day dish 1.9	0	1	5	2	4	5,58	12	2,07	2,4	86,25
Second courses	2.1	Grilled salmon	7	4	8	7	3	13,49	29	2,17	5,8	37,41
	2.2	Squid	6	6	5	9	5	14,42	31	1,64	6,2	26,45
	2.3	Pig's cheek	5	8	6	3	5	12,56	27	1,82	5,4	33,7
	2.4	Steak	3	3	4	6	5	9,77	21	1,3	4,2	30,95
	2.5	Duck confit	0	3	2	2	7	6,51	14	2,59	2,8	92,5
	2.6	Escalope	3	4	4	6	9	12,09	26	2,39	5,2	45,96
	2.7	Sausage	8	6	5	6	6	14,42	31	1,1	6,2	17,74
	2.8	Day dish 2.8	2	2	5	2	0	5,12	11	1,79	2,2	81,36
	2.9	Day dish 2.9	0	3	4	1	9	7,91	17	3,51	3,4	103,24
Desserts	P.1	Catalan cream	12	10	10	7	9	22,33	48	1,82	9,6	18,96
	P.2	Flan	10	11	10	12	12	25,58	55	1	11	9,09
	P.3	Pudding	2	3	4	5	6	9,3	20	1,58	4	39,5
	P.4	Ice Cream	7	5	8	6	9	16,28	35	1,58	7	22,57
	P.5	Cake	6	6	7	7	8	15,81	34	0,84	6,8	12,35
	P.6	Yogurt (Handmade)	1	2	1	2	3	4,19	9	0,84	1,8	46,67
	P.7	Fruit	2	2	3	3	2	5,58	12	0,55	2,4	22,92

Figure. 28 Number of Orders table

Figure. 1 Makigami

As can be seen in the table, mixed salad, macaroni, squid, sausage, Catalan cream and flan are the dishes most in demand by the customer. On the other hand, the dishes of the day, in duck confit and natural yoghurt, are the ones that customers order less frequently.

Next, we calculated the Sigma (σ) and Mu (μ) to know the variability. The Standard deviation is a measure of dispersion, which indicates how far the values can deviate from the average (mean value), so it is useful to look for probabilities that an event will occur, or in this case, to determine between which ranges the choice of a certain dish can be moved.

In order to define well the orders we will be interested in a constant choice of dishes in order to guarantee an optimal stock.

Therefore it would be convenient to eliminate those dishes that have a high deviation because it means that the choice by customers is very random and this will make there are days that cannot meet the needs and others that there is a lot of waste because of not being able to give exit to that stock.

If we want to have an acceptable level of on-time sales, i.e. approximately 84% (probability of being 84% of the time in our series), we need to work with at least a sigma of approximately 0.99=1. Sigma is just the standard deviation of the distribution we are dealing with. In our case we will take the consumption data of one working week (5 days).

So, after doing this calculation we observe that the dishes that have the greatest variability are those that we could eliminate. Then, for example, we could eliminate the dishes of the day (86%, 81% and 103%) from the menu of the day and thus also save on costs.

Taking 84% of sales as an acceptable level, we will calculate the Buffer and Safety in the Supermarket.

4.3.1 Supermarket calculation

Proper stock management (quantity, location, etc...) will allow less time to be spent on the warehouse and order management process. If you have control over the location of each reference, you won't need to waste time looking for where a certain product was left.

In addition, if all products are regularly visually tracked, detecting those that need to leave urgently, the losses caused by throwing products away will be reduced.

For this reason, a quantitative analysis has been calculated on the most sold dishes in order to find the optimum stock and thus optimize the available resources to the maximum. With this calculation, the average weekly stock quantity for each ingredient has been found.

Below is a table where there are some examples of the supermarket calculation. To make the calculation we have selected the best-selling dishes because they will be the ones that will have to be replaced first.

The ingredients that make up the dishes have been accounted for through product units.

Our Lead Time is 5 days, as suppliers provide us with food every 5 days, so all orders will be placed every week.

Av. day	Days work	Av. week	Dish	Ingredients	Quantity	Uni.	TT	LT	Cyclic Stock of Units	Buffer (%)	SAFETY (%)	C+B+S	U X Pack	Cyclic Pack Stock
8,2	5	41	Mixed Salad	Lettuce	0,25	u	0,49	5	10,25	10,24	3	10,38	12	1
8,2	5	41		Tomato	0,5	u	0,24	5	20,5	10,24	2	20,62	25	1
8,2	5	41		Onion	0,25	u	0,49	5	10,25	10,24	2	10,37	6	2
8,2	5	41		Tuna	0,13	u	0,94	5	5,33	10,24	2	5,45	1	6
6	5	30	Macaroni	Macaroons	0,01	u	16,67	5	0,3	26,33	2	0,58	1	1
6	5	30		Meat	0,16	u	1,04	5	4,8	26,33	2	5,08	1	6
6	5	30		Tomato sauce	0,05	u	3,33	5	1,5	26,33	2	1,78	1	2
6,2	5	31	Squids	Squids	1	u	0,16	5	31	26,45	2	31,28	5	7
6,2	5	31		Flour	0,07	u	2,30	5	2,17	26,45	2	2,45	1	3
6,2	5	31		Eggs	0,5	u	0,32	5	15,5	26,45	2	15,78	36	1
6,2	5	31	Sausage	Sausage	1	u	0,16	5	31	17,74	2	31,20	6	6
6,2	5	31		Potato	1	u	0,16	5	31	17,74	2	31,20	25	2
6,2	5	31		Artichoke	1	u	0,16	5	31	17,74	2	31,20	12	3
9,6	5	48	Catalan Cream	Eggs	1	u	0,10	5	48	18,96	2	48,21	36	2
9,6	5	48		Milk	0,125	u	0,83	5	6	18,96	2	6,21	1	7
9,6	5	48		Sugar	0,01	u	10,42	5	0,48	18,96	2	0,69	1	1
9,6	5	48		Flour	0,0375	u	2,78	5	1,8	18,96	2	2,01	1	3
11	5	55	Flam	Eggs	1	u	0,09	5	55	9,09	2	55,11	36	2
11	5	55		Milk	0,125	u	0,73	5	6,875	9,09	2	6,99	1	7
11	5	55		Sugar	0,02	u	4,55	5	1,1	9,09	2	1,21	1	2

In order to calculate the number of boxes we need to buy to cover the restaurant's needs, we first needed to know the average number of dishes consumed per day (Av.day) and the Takt Time (TT) of each ingredient that makes up the dish. From this data we know the Cyclic Stock of Units.

Example of the calculations with the Mixed Salad:

- Average daily consumption:
    - 8,2 Mixed Salads.
- Ingredients that we need:
    - 0,25 u. Lettuce
    - 0,5 u. Tomato
    - 0,25 u. Onion
    - 0,13 u. Tuna
- Calculation of the Tack Time:
    - Lettuce:

$$TT_L = \frac{1\ day}{8{,}2\ x\ 0{,}25} = \frac{1}{2} = 0{,}49 \cong 0{,}5\ day/Lettuce$$

    - Tomato

$$TT_{To} = \frac{1\ day}{8{,}2\ x\ 0{,}5} = \frac{1}{4} = 0{,}24 \cong 0{,}25\ day/Tomato$$

    - Onion

$$TT_O = \frac{1\ day}{8{,}2\ x\ 0{,}25} = \frac{1}{2} = 0{,}49 \cong 0{,}5\ day/Onion$$

    - Tuna

$$TT_{Tu} = \frac{1\ day}{8{,}2\ x\ 0{,}13} = 0{,}94 \cong 0{,}9\ day/Tuna$$

- As stated above, we assume a 1-week (5-day) provider replenishment lead time. Thus, the calculation of the cyclical stock for each product is as follows:
    - Lettuce:

$$C_L = \frac{LTrep.}{TTlettuce} = \frac{5}{0{,}5} = 10$$

- Tomato

$$C_{To} = \frac{5}{0{,}25} = 20$$

- Onion

$$C_{O} = \frac{5}{0{,}5} = 10$$

- Tuna

$$C_{Tu} = \frac{5}{0{,}94} = 5{,}33$$

- With the results obtained from the calculation of the cyclical stock, we are only covering the average demand, but I have to take into account that my client has variability.
  Then, the extra stock to cover this variability is calculated through the Buffer in the following way:

$$Buffer = \frac{\sigma}{\mu}$$

$$B_{Mixed\ Salad} = \frac{0{,}84}{8{,}2} = 10{,}24 \cong 10\%$$

- The Buffer is applied in percentage and is the same for all ingredients as it is calculated per plate. Then, this Buffer will have to be added to the Cyclic Stock of each product, in our case approximately 10%.

- Finally, we need to know the Safety, a fixed value based on the history. We set the value on the basis that 2 out of 100 dishes are wasted (because of inefficiencies). Therefore, the value of the Safety will be 2%:

$$Safety = \frac{2}{100} = 0{,}02 = 2\%$$

- To conclude, we need to know the Order Point: the smallest number of a particular product that a business allows itself to have, before ordering more. Through the order point we will be able to know the minimum total number of products that we have to buy to cover the needs of the restaurant on a weekly basis:

Order Point = Cyclic Stock + Buffer + Safety O.P. = C+ B + S

- Lettuce:

$$O.P_L = 10{,}25 + 10{,}24\% + 2\% = 10{,}38$$

- Tomato

$$O.P_{To} = 20{,}5 + 10{,}24\% + 2\% = 20{,}62$$

- Onion

$$O.P_O = 10{,}25 + 10{,}24\% + 2\% = 10{,}37$$

- Tuna

$$O.P_{Tu} = 5{,}33 + 10{,}24\% + 2\% = 5{,}45$$

- At this point, we already know the quantities that we need to order in the weekly purchase and, knowing the units of product that come in each pack that we buy (since the units of product per pack are defined and you cannot buy for example 10.38 lettuce if not we will have to buy 11) we can define how many packs of each product we will buy.

Dish	Ingredients	C+B+S	U X Pack	Cyclic Pack Stock
Mixed Salad	Lettuce	10,38	12	1
	Tomato	20,62	25	1
	Onion	10,37	6	2
	Tuna	5,45	1	6

Figure. 30 Example of supermarket calculation

So, as we can see in the table we will have to buy the following packs to cover our needs:

- 1 pack of 12 lettuces.
- 1 pack of 25 tomatoes.
- 2 packs of 6 onions.
- 6 pack of tuna.

Once the calculation has been made for all the products as can be seen in the Figure 30, we can now design our supermarket according to the weekly purchase and what we need for each pack.

- To find out when I need to call the supplier to make the purchase, we have added to our supermarket, dynamic shelving (FIFO-First In First Out), with a marks of green, yellow and red colours. As we run out of product we will reach the yellow marks that inform us that the product is running out that will remind us that you have to call the supplier to buy back. We should only start using a new pack when the old one has been completely used up (to avoid product mixes and ensure FIFO).

Figure. 31 Proposed dynamic shelving.

The supermarket makes the existing inventory transparent as there is a place for everything and everything is in place. The identification of the places corresponding to each reference is easy.

On the other hand, the supermarket can easily limit the maximum stock level and we can define a minimum stock level.

5. CONCLUSIONS

From this work we have been able to see how the application of lean management in another sector than the industrial one, as in this case the catering sector, is effective.

After identifying all the problems that the restaurant to study had, from the Ishikawa diagrammed we were able to act on them through the Lean tools.

The main problems referred to the work methodology they followed and to the workers themselves, since the roles and activities of each one were not well defined, there were problems of communication and organization and the distribution of the kitchen was not the most appropriate.

From the final spaghetti chart made after the implementation of the 5s, we could see how many of the deficiencies initially found had been reduced. The new distribution of the kitchen, the definition of the roles of each worker and the organization of the activities carried out by each one have helped to reduce the number of clashes between them have, to make communication clearer and, above all, to avoid unnecessary displacements by having a logical order and distribution of the machines and tools needed to work in the restaurant.

Through the collection of real data we have been able to know the real time that each worker invested per table and that if we wanted to increase our profits we had to balance the activities among the workers to match the time spent per table and thus increase the work capacity.

Finally we have carried out a study based on the variability of the choice of dishes of the customers. From this study we have been able to eliminate some dishes from the menu and we have been able to make a supermarket based on the best-selling products through dynamic shelving to optimize purchases from suppliers and increase business profits.

In conclusion, these are the benefits of applying Lean Management:

Figure. 32 Lean Management benefits (improofsolutions.com)

Safe workplace, by reducing movements and organizing kitchen tools, eliminating all unnecessary items from the restaurant and creating a safe and effective work plan. Also, adding an oval eye to the bathroom door to avoid collisions.

Environmental Impact, by reducing the amount of food thrown away and buying as needed.

Quality, increasing the quality of service by reducing errors and inefficiencies, such as with the implementation of PDAs and digital screens, reducing movement and eliminating the problem of understanding the letter of the head waiter.

Cost Reduction, increasing profits by increasing work capacity by equalizing the times workers spend per table. We also reduce costs with the creation of the supermarket because we will only buy what is needed and we will eliminate the stock.

Customer Satisfaction is good as we have seen that 80% of customers repeat. Customer service has become more personalized with the head waiter (Maître) in the dining room at all times.

Employee Motivation and Engagement is achieved through a good work plan and by giving responsibilities to employees and making regular evaluations of them.

We can always continue to standardize and work on the first action plan to improve little by little and get closer to the ideal process.

5.1 PERSONAL CONCLUSIONS

The implementation of this project has been very successful. Having been able to work through each Lean tool and see its impact and consequence has made the work more interesting.

It has not been an easy job because working in a sector that has not been well studied and where workers have no knowledge of Lean Management model or economics has made the task longer and more expensive. Explaining what we were doing and the solutions proposed to the owners who are also part of the staff of the restaurant is complicated because they have been working in restaurant sector their way through life.

It should be noted that despite not knowing the Lean management model, the workers themselves found ways to solve some of their problems and had ideas on how to improve the restaurant's service thanks to their experience, ideas that we also learned from.

So, what is really important about the work we have done is that we have managed to apply Lean principles in a company of 4 workers, when this application is usually done in large companies with people dedicated to it.

In short, we can say that the study and application of Lean Management in the restaurant has been satisfactory and that we have learned a lot during the whole process.

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ANNEX 1

Below are all the tables on actual data collection during the study at the restaurant. We can see the actual times of each operation, its duration and the time used per person and per table, both individually and collectively.

WORKS CYCLES	TASKS	REPLAYS	TIME FRAME (Seconds)	TOTAL (Seconds)	TIME PERSON (Seconds)	TIME PERSON (Hours)	TIME ALL TABLES (Hours)	TABLE INDIVIDUAL TIME(Min)
Morning cycle (11:00 - 13:00)	Clean dining room	1	1200	1200				1,428571429
	Clean the toilets	2	900	1800				2,142857143
	Clean the entrance	1	600	600				0,714285714
	Lay the tables	1	120	120				0,142857143
	Recharge beverage coolers	1	1020	1020				1,214285714
	WAITERS TOTAL			4740	2370	0,7	0,1	5,6
	Prepare the dishes of the day	1	1800	1800				2,142857143
	Prepare first courses	1	1200	1200				1,428571429
	Prepare second courses	1	1200	1200				1,428571429
	Recharge food coolers	1	1080	1080				1,285714286
	CHEFS TOTAL			5280	2640	0,7	0,1	6,3
TOTAL				10020	5010	1,4	0,2	11,92857143
Afternoon cycle (16:00 - 17:00)	Pick up and clean the tables	7	180	1260				1,5
	Lay the tables	7	90	630				0,75
	Sweep up	1	600	600				0,714285714
	Recharge beverage coolers	1	900	900				1,071428571
	Place the cleans dishes	1	600	600				0,714285714
	Take out the trash (bottles and cans)	1	780	780				0,928571429
	Cash up the cash	1	420	420				0,5
	WAITERS TOTAL			5190	2595	0,7	0,1	6,2
	Clean the kitchen	1	1800	1800				2,142857143
	Put the dishes in the dishwasher	2	150	300				0,357142857
	Remove and dry didishes from	2	360	720				0,857142857

	the dishwasher							
	Clean the sink, sweep and scrub	1	900	900				1,071428571
	Recharge food coolers	1	780	780				0,928571429
	Take out the trash	1	180	180				0,214285714
	Cash up the cash	1	420	420				0,5
	CHEFS TOTAL			5100	2550	0,7	0,1	6,1
End of the afternoon cycle				10290	5145	1,4	0,2	12,3